INDOOR AIR QUALITY ASSESSMENT

Veterans Memorial High School
485 Lowell Street
Peabody, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of school officials and the Peabody Teacher's Association, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding continued indoor air quality concerns at Peabody Veterans Memorial High School (PVMHS). The school was originally visited in 1997 by BEHA staff. A report was issued (MDPH, 1997) which described the conditions of the building at that time. The 1997 report showed that there were problems identified and provided recommendations on how to correct those problems. On January 15, 17 & 18, 2002, visits were made to PVMHS by staff from BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) Program. BEHA staff were accompanied by Ed Sapienza, President of the Peabody Federation of Teachers, James Nangle, Indoor Air Quality Liason, Kevin McHugh, Assistant to the Superintendent, and Joe Patuleia, Principal of PVMHS during portions of the assessment.

PVMHS is a three-level complex built in 1973. The building is configured with three interior courtyards (ICs) located in the center of the building (see Figure 1). Three open courtyards [exterior courtyards (ECs)] exist on the eastern side of the building. The first level is primarily made up of special-use rooms/areas such as the cafeteria and kitchen, industrial arts, the field house, cosmetology program, the auditorium and office space. The second level consists of general classrooms, science rooms, laboratories, main administrative offices and special purpose rooms (e.g. band, art and food preparation classrooms). The third level is predominantly comprised of general-use classrooms. The windows in the building are of a sliding design, which are openable in most classrooms. Several classroom and office spaces do not have openable windows. A review of actions taken on previous BEHA recommendations is provided in Appendix 1.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor Model 8551. Screening for total volatile organic compounds (TVOCs) was conducted in the vocational education wing using an HNu Systems, Photo Ionization Detector (PID). Outdoor background TVOC measurements were taken for comparison to indoor levels.

Results

This school has a student population of approximately 1,500 and a staff of approximately 300. Tests were taken during normal operations at the school and results appear in Tables 1-27.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million parts of air (ppm) in more than 50% of areas surveyed on January 15; in approximately 25% of areas surveyed on January 17 and in 33% of the areas on January 18, indicating a ventilation problem in a number of areas in the school. Over the course of the three days of air monitoring, sixty-eight out of one hundred seventy three areas (~39%) had carbon dioxide levels in excess of 800 ppm. Forty-seven out of one hundred seven areas (~44%) had carbon dioxide levels above 800 ppm during the January 17, 1997 assessment. It is also important to note that a large number of classrooms had open windows during the assessment, which can greatly contribute to reduced carbon dioxide levels. Of note was room C-394 that had a carbon dioxide level of over 2,000 ppm with the windows open indicating little to no air exchange. These levels seem to indicate that the efficiency of the ventilation system is still inadequate for providing fresh air for PVMHS classrooms and offices.

Fresh air in most classrooms is supplied by a unit ventilator (univent) system. Univents in exterior classrooms draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air through an air intake located at the base of each unit (see Figure 1). Interior rooms contain ceiling-mounted univents that are ducted to fresh air intakes on the roof. Fresh and return air are mixed, filtered, heated and provided to classrooms through an air diffuser located in the top of the unit.

Univents were found deactivated in a number of classrooms reportedly due to lack of temperature control, noise or other malfunctions, which can indicate problems with the pneumatic system or thermostatic control. Partial obstructions to airflow, such as papers and books stored on univents and bookcases, carts and desks in front of univent returns were seen in a number of classrooms. In order for univents to provide fresh air as designed, intakes must remain free of obstructions. Importantly, these units must remain "on" and allowed to operate while these rooms are occupied.

Although some parts have been replaced and filters have been upgraded, the univents are original equipment installed thirty years ago. Fresh air diffusers of many univents were damaged. Damaged fresh air diffuser grilles were replaced with plexiglass or metal sheets with cut slots to allow for air to escape the univent (see Picture 1). Univents with these repairs have restricted airflow, since the apertures through which air must pass are smaller than univents with intact fresh air diffuser grilles (see Picture 2). This restriction of airflow may result in degradation of operation as well as life span of univent motors, fans and fan belts which were designed to operate at a lower air pressure by the large surface area of the original fresh air diffuser grilles. The decrease of function of these univents may lead to an inadequate fresh air supply as well as premature degradation of calibration of air velocity of univent fresh air intakes.

Exhaust ventilation in most classrooms is provided by a mechanical system consisting of ceiling vents enclosed by sheet-metal lockers powered by rooftop motors (see Picture 3). In some classrooms, air is returned through a passive door vent and exhausted by a ceiling-mounted exhaust in an adjacent room (i.e., air is pulled through the door vent and out the vent in the adjacent room). As with the univents, a number of exhaust vents were obstructed, deactivated or in disrepair (see Picture 4). In order for exhaust ventilation to function as designed, vents must be activated and remain free of obstructions. With the absence or minimization of mechanical exhaust ventilation, pollutants generated during building occupancy will tend to linger.

Mechanical ventilation in offices and common areas (auditorium, library, gymnasium/locker rooms, etc.) is provided by air handling units (AHUs). Air is distributed by ducted ceiling vents located throughout the building. Exhaust ventilation is provided by wall or ceiling-mounted grates that return air back to the AHUs via ductwork. Numerous complaints of poor ventilation were received in these areas (see Tables).

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. According to school department officials, the date of the last balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings were within the following ranges: a range of 67^{o} F to 76^{o} F on January 15, 2002; 65^{o} F to 75^{o} F on January 17, 2002; and 62^{o} F to 79^{o} F on January 18, 2002. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Temperature control complaints were expressed to BEHA staff in numerous areas building-wide. It is difficult to control temperature and maintain comfort without the air handling equipment operating as designed (e.g., univents deactivated, non-operable exhaust motors). In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. While temperature readings outside the recommended range are generally not a health concern, increased temperature can affect the relative humidity in a building.

The school contains a number of computer rooms. Computer equipment and printers can generate waste heat while they operate, which can build up over time in an area without adequate ventilation. Lack of ventilation can lead to poor air quality and comfort complaints.

The relative humidity in the building was below the BEHA recommended comfort range in all areas sampled during the visits. Relative humidity was measured in the following ranges during this assessment: 25 to 37 percent on January 15, 2002; 20 to 33 percent on January 17, 2002; and 15 to 26 percent on January 18, 2002. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels would be expected to drop during the winter months. The sensation of dryness and irritation is common in a low relative humidity environment. Humidity is more difficult to control during the winter heating season. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A number of conditions noted in the building indicate that water accumulation and/or penetration exists in the window and exterior wall systems of the PVMHS. This moisture accumulation may be the source of materials degradation noted on heating coils of univents examined.

In order to explain how water penetration occurs through exterior wall systems, the following concepts concerning moisture and wall systems must be understood.

- Exterior wall systems, brick, cement and mortar contain water, which allows moisture movement through these materials;
- Wind driven rains increase water penetration through exterior wall systems, brick, cement and mortar;

- Exterior wall systems, brick, cement and mortar must dry in a timely fashion to prevent opportunistic microbial growth; and
- Gravity will direct water in a building towards the ground.

Exterior wall systems should be designed to prevent moisture penetration into the building interior through the use of a drainage plane within the wall system to redirect water outdoors and allow for building components to dry. An exterior wall system should consist of an exterior curtain wall (see Figure 3). Behind the curtain wall is an air space that allows for water to drain downward and for the exterior cladding system to dry. At the base of the curtain wall should be holes that allow for water drainage (called weep holes). Opposite the exterior wall, across the air space, is a continuous, water-resistant material adhered to a wall (the back up wall) which forms the drainage plane.

The purpose of the drainage plane is to prevent moisture that crosses the air space from penetrating into interior building systems and to direct that moisture downward to the weep holes. The drainage plane can consist of a number of water-resistant materials, such as tarpaper or in newer buildings, plastic wraps. The drainage plane should be continuous. Where breaks exist in the drainage plane (e.g., window systems, door systems and univent fresh air intakes), the penetrations have materials added (e.g. copper flashing) to direct water to weep holes. If the drainage plane is discontinuous, missing flashing or lacking an air space, rainwater may accumulate inside the wall cavity and lead to moisture penetration into the building.

The exterior of the PVMHS consists of a traditional red brick exterior wall on the first floor of the building (see Picture 5). The upper stories consist of a metallic cladding system that rests on top of the brick curtain wall (see Picture 6). Visual inspection of the material could not determine the type of metal used to fabricate the exterior metallic cladding system. If the exterior cladding was made of steel, a simple magnet would be attracted to and adhere to the surface. A magnet was obtained from the science department and applied to the exterior cladding system. This exterior wall system attracted the magnet, indicating that the exterior wall system is most likely steel. The steel wall system consists of panels that are inserted into a frame. No gasket system exists between steel panels, which allows for water to freely move into the air space between the exterior panel and drainage plane. The steel exterior wall system is positioned in a manner to allow for water penetrating into the system to drain into the red brick exterior wall system of the first floor (see Picture 7). In order to allow for water to drain from the exterior brick wall system, a series of weep holes is customarily installed at or near the foundation slab/exterior wall system junction (see Figure 3). The purpose of a weep hole is to allow for accumulated water to drain from a wall system (Dalzell, J.R., 1955). Failure to install weep holes in brickwork will allow water to accumulate in the base of walls, resulting in seepage and possible moistening of building components (see Figure 4).

An extensive examination of the exterior brick walls of PVMHS was conducted to identify the location and condition of weep holes. Weep holes were found approximately three feet above the ground, located on the north and east facing exterior walls (see Picture 8). Of note is that each weep hole was blocked with a wick material (see Picture 9). Most weep holes in these walls have wicks installed. Wicks were originally installed to enhance water movement from the drainage plane. Over time, sediment accumulation turns the wick into a stopper, which prevents water drainage from the exterior wall system. It is not recommended to "use ropes or tubes for weep[hole]s" (Nelson, P.E., 1999).

The field house has weep holes that are located at the brick/slab junction, several inches off the ground (see Picture 10). The western exterior brick wall is recessed under the second and third floors, removing it from the steel exterior wall system drainage plane (see Picture 11). The auditorium had no identifiable weep hole system along its south exterior wall. Since the auditorium is of similar design to the field house exterior wall, weep holes in this section may be buried by accumulated loam, dirt or cedar flakes along the edge of these walls. It is advised that "[i]n no case should the holes be located below grade", since dirt can fill weep holes to prevent drainage (Dalzell, J.R., 1955).

Of note are the exterior walls that form the ECs on the eastern side of the building (see Figure 1). No weep holes were identified in any of the exterior brick wall system that forms these courtyards in a manner that would be consistent with other areas of the PVMHS. Either weep holes were not installed or are buried below grade. The steel exterior wall system of the courtyards shows signs of significant water exposure, which would direct moisture into the walls of the courtyard.

The ICs were also examined. Some walls of the north and central ICs appear to have weep holes of a similar design to the field house. The presence of weep holes in the south IC could not be determined.

In order to ascertain the condition of the exterior wall system, the fresh air intake grill should be removed from several univents to check for the presence of a sheet metal duct connecting the grill to the univent. If no such duct exists, air may be drawn from the drainage plane by univents. Under certain circumstances, materials accumulated in the wall drainage plane (e.g., water vapor and microbial growth) may be drawn into univents and dispersed indoors (see Figure 5). The presence of water vapor in univents is confirmed by the presence of corrosion on the underside of heating coils in univents on the third floor. Heating coils are made of steel (confirmed by magnetic attraction using the same magnet used on the exterior metallic cladding system), which when exposed to water vapor, will corrode to form iron oxide (rust).

Another area that had significant accumulation of iron oxide was the floor of room 243 (see Pictures 12, 12A). This area is served by an air handing unit (AHU) that draws fresh air from the center IC. The floor of the fresh air intake had accumulated water, which appears to enter the duct through a seam in the sheet metal of its floor (see Picture 13). Of note is the wall beneath the fresh air intake for this AHU, which remained moistened for several days after the first day of the current assessment (see Picture 14). This condition may indicate accumulation of water within the exterior wall system. It is believed that the source of iron oxide found on the floor of room 243 was from the heating coil of the AHU connected to this wall.

The findings of rust on heating coils and water vapor sources in exterior walls may account for the periodic reports of metallic taste from building occupants. As moisture contacts the corroded heating coil, it is possible that an iron oxide/water solution is created, which is then aerosolized by a combination of airflow and evaporation by the functioning univent. Iron oxide exposure in this manner is not considered a health hazard, but may result in the decrease in comfort of building occupants. This possible source of moisture penetration is problematic if it is present within the air stream of the univents. Without a sleeve to isolate the air stream from the wall system, odors and other materials can then be drawn into univents. This problem would be expected to occur during or immediately following rainstorms that wet the exterior wall systems. Further examination is warranted to determine whether water accumulation is occurring in this manner.

A walkway exists on the second floor on the north wall of the south EC. This walkway is covered with a corrugated steel roof, which directs rainwater directly into the south EC. No gutter or downspout system exists to capture and direct rainwater from the base of the north exterior wall of the south EC. This wall consists of a large window system. Chronic water exposure to the wall is evidenced by the accumulation of moss on the wall. Rainwater must be directed away from the base of exterior walls to prevent water pooling and possible penetration into interior areas.

A number of classrooms and common areas throughout the building have water-damaged ceiling tiles and other building materials, which indicate leaks from either the roof or plumbing system. Active roof leaks were reported in classroom B-354 as a result of a drain leak. Possible mold growth was identified on a ceiling tile directly below this area (see Pictures 15 & 16).

Throughout the building, window frame rubber gaskets and caulking around the interior and exterior windowpanes were loose, missing or damaged. In some windows, no gasket system was installed along the top of window frames (see Picture 17). Air infiltration was noted around windows in some areas. Further, some areas had ripped screens and broken windowpanes (see Pictures 18 & 19). Water vapor was observed collecting inside the double-paned windows in many areas (see Pictures 20 & 21). This indicates that window seals are no longer intact. Repairs of window leaks are necessary to prevent further water penetration. Repeated water damage can result in mold colonization of window frames, curtains and items stored on windowsills.

Several classrooms contained a number of plants. In some classrooms plants were seen on top of univent air diffusers. Plant soil and drip pans can serve as a source of mold growth. Plants should be located away from univents and exhaust ventilation to prevent aerosolization of dirt, pollen or mold.

Of note is the absence of a complete gutter/downspout system to direct rainwater from the base of the exterior walls (gutters are only installed over exterior doors). After rainstorms, the exterior walls are saturated with moisture. Rainwater runs off the roof onto the ground at the base of the building. This runoff has created a trench parallel to the base of the wall, which allows rainwater and melting snow to pool against the foundation and the exterior walls. Splashing water along the edge of the building wets the base of exterior walls creating a characteristic stain (see Picture 22). Growth of moss on exterior brickwork is another indication of chronic moisture exposure from rainwater. Moss growth also holds moisture against brickwork. North facing corners and walls of the building are particularly vulnerable to moisture for extended periods of time, since this brick is not dried by exposure to direct sunlight. Excessive exposure to water of exterior brickwork can result in damage over time. Also observed was moss growth inside the inner lip of univent air intakes. The design of the fresh air intake allows for accumulation of water and debris, which can in turn be drawn into univents and distributed into occupied areas.

Along the perimeter of the building, shrubbery and flowering plants were noted in close proximity to a univent fresh air intake outside of one classroom (see Picture 23).

Shrubbery and flowering plants can be a source of mold and pollen and should be placed and/or maintained to ensure that fresh air intakes remain clear of obstructions.

Evidence of bird nesting was observed in various locations of the eaves of the building. Bird waste was observed on brickwork below the eaves. Birds can be a source of disease, and bird wastes and feathers can contain bacteria and fungi, which can be irritating to the respiratory system.

Water coolers were observed on carpeted areas in a few locations. To avoid water damage to carpeting and/or potential mold growth, a water-resistant material such as plastic or rubber matting should be installed beneath water coolers.

Several classrooms had aquariums. Picture 24 shows an aquarium that was cloudy with mold/algae growth. Aquariums should be properly maintained to prevent mold/bacterial growth and/or unpleasant odors.

Other Concerns

A number of other conditions were noted during the assessment, which can affect indoor air quality. The south EC had an AHU installed on the ground that appears to service a kitchen area. During this assessment, this AHU was found to be emitting carbon monoxide from an exhaust port on its side (see Picture 25). This AHU uses natural gas to heat air, which can produce products of combustion, including carbon monoxide. The location of the fresh air intake for this AHU will make it prone to entrain pollutants from plants and soil. Its location will also make its cabinet prone to corrosion from moisture.

BEHA staff received several complaints concerning vehicle exhaust odors. Historic complaints of vehicle exhaust entrainment due to the design and location of fresh air intakes have been documented previously. At the time of the reassessment, no vehicle exhaust odors or measurable levels of carbon monoxide were detected within the school. However, a number of vehicles were seen idling and/or parked in close proximity to air intakes during the school day (see Picture 26), which can result in vehicle exhaust entrainment by the mechanical ventilation system and open windows under certain weather conditions. This may, in turn, provide opportunities for exposure to combustion products such as carbon monoxide. M.G.L. chapter 90 section 16A prohibits the unnecessary operation of the engine of a motor vehicle for a foreseeable time in excess of five minutes (MGL, 1996).

Several areas had open utility holes and missing/dislodged ceiling tiles. Missing ceiling tiles can provide an egress for dirt, dust and particulate matter into occupied areas. Also of note was the amount of materials stored in some areas. Items were seen piled on windowsills, tabletops, counters, bookcases and desks in classrooms throughout the school. The large amount of items stored allows for dusts and dirt to accumulate. These stored items, (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Dust can be irritating to the eyes, nose and respiratory tract.

Several classrooms contained dry erase boards and dry erase board markers. Accumulated chalk dust or dry erase board particles were noted in several classrooms. These materials are fine particulate, which can be easily aerosolized and serve as eye and respiratory irritants. In addition, materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can also be irritating to the eyes, nose and throat.

The main office and teachers' lounges have photocopiers. VOCs and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). In order to help reduce excess heat and odors in these areas, common household fans were mounted into office windows (see Picture 27). School personnel should ensure that fans are activated while equipment is in use.

The dryer for the consumer science area is ducted out of the building below a univent air intake (see Picture 28). Although the vent empties downward away from the air intake, the possibility of re-entrainment of dryer exhaust is possible depending on certain wind and weather conditions.

The art room contains two pottery kilns, which are also vented to the outside. Pottery kilns can produce carbon monoxide and sulfur dioxide, which can cause respiratory symptoms in exposed individuals. BEHA staff noted strong kiln odors in the general vicinity with the exhaust operating. The kilns are connected to the exhaust ductwork by flexible hoses. It appeared that the hoses were too long, each forming a hairpin turn before entering the ductwork (see Picture 29). Airflow is decreased roughly in half by every 90^{o} angle that exists in ductwork. The ductwork contains over 180^{o} of angles. If the draw of fresh air by the exhaust fan was 100 percent, the angles of this ductwork would reduce that draw to approximately 25 percent.

Exposed fiberglass insulation was observed around univents in a number of classrooms (see Picture 30). Fiberglass insulation can be a source of skin, eye and respiratory irritation to sensitive individuals. A number of areas had portable air purifiers and/or wall-mounted air conditioning units. BEHA staff inspected filters in a number of these units and found them coated with dirt/dust (see Pictures 31 & 32). Without cleaning/changing filters, the activation of these units can re-aerosolize dirt, dust and particulate, which can be irritating to certain individuals.

The chemical storage room contained a number of hazardous chemicals stored in a manner that could impact indoor air quality. The following conditions are examples of improperly stored chemicals:

- Metal fixtures beneath the sink appear to be heavily corroded, which can indicate the presence of off-gassing chemicals. Improperly sealed acid containers can off-gas resulting in corrosion.
- Bottles of acids (hydrochloric acid and sulfuric acid) were noted stored in and around the sink. Acids should be stored separately from water sources. Acids should be stored in an acid resistant cabinet.
- Reactive materials (nitric acid and ammonia) are stored on the same shelf.
- A corroded can of duplicating fluid was noted in this area. Metal canisters can be degraded when exposed to acidic and alkaline material and should be stored in a flammables storage cabinet that meets the specifications of the NFPA (NFPA, 1996).
- Flasks containing chemicals were sealed with either stoppers made of cork or plastic wrap held in place with rubber bands. Use of these materials can lead to the slow evaporation of materials from these containers.
- Reuse of original bottles for storage of other chemicals.

- Electrical pipes penetrate through the ceiling tiles if this room. Evaporating chemicals can penetrate through spaces in the ceiling plenum and be distributed into adjacent areas.
- Flasks filled with chemicals are labeled by chemical formula and not name.

Science classrooms contain chemical hoods. Several materials were noted stored within a chemical hood, including ammonia and hydrochloric acid. The exhaust fans for the chemical hood were deactivated. The chemical hood exhaust ventilation should be operational at all times that materials are within this equipment to remove off-gassing vapors and odors. Stock bottles of chemicals should be returned to chemical storage areas once experiments have been completed.

The woodshop is located on the first floor. The woodshop has local exhaust ventilation for wood cutting/sanding machines. A wood dust collector exists in this room. This wood dust collector is not ducted to the outdoors, but is allowed to exhaust into the room. Since the wood dust collector is not designed to filter small diameter particles, the use of this machine without ducting outdoors may aerosolize wood dust to allow for inhalation. Excessive amounts of wood dust on flat surfaces indicate that wood dust aerosolization is occurring. Heavy wood dust accumulation was also seen inside univents, which can be reaerosolized and distributed throughout the wood shop via the air diffuser. Wood dust can be irritating to the eyes, nose, throat and respiratory system. Under certain conditions, wood dust is a fire hazard.

Also noted in the room were open cans of shellacs, wood finisher and paint thinner. Several cans in this area appear to be corroded, which can lead to container failure. These products contain volatile organic compounds (VOCs) which evaporate readily and can be irritating to eyes, nose and throat. These products are flammable as well, and should be stored in a cabinet which meets the criteria set forth by the National Fire Protection Association (NFPA) (NFPA, 1996).

The woodshop also had a passive vent over the door leading to the hallway, which can result in odors and dust penetrating into the hallway and adjacent areas. This vent should be sealed to prevent woodshop dusts/odors from spreading to adjacent areas of the school.

A room adjacent to the woodshop contains a spray booth. The exhaust for this spray booth is located on the roof, in close proximity to fresh air intakes on the roof. VOCs from paints used in the spray booth can be entrained into these fresh air intakes and distributed to occupied areas of the school.

Conclusions/Recommendations

The conditions noted at the Peabody Veteran's Memorial High School suggest that moisture and ventilation issues are contributing largely to indoor air quality complaints. The combination of the design of the building, maintenance, condition of HVAC equipment and the limited availability of replacement parts, work hygiene practices and the condition of stored materials in the building, present conditions that can adversely influence indoor air quality. Some of these conditions can be remedied by actions of building occupants. Other remediation efforts will require alteration to the building structure and equipment. For these reasons a two-phase approach is required, consisting of **short-term** measures to improve air quality and **long-term** measures that will require planning and resources to adequately address overall indoor air quality concerns.

In view of the findings at the time of the visits, the following **short-term** recommendations are made:

1. Fully investigate and address the exterior wall system and univent systems. In order to best carry out this recommendation the following steps are necessary:
    a) Removal of several univents on ICs and ECs to examine the installation, interior wall conditions and potential influence on the entrainment of materials via the ventilation system;
    b) If univent removal is not practical, removal of several exterior univent fresh air intake grilles to examine the installation, interior wall conditions and potential influence on the entrainment of materials via the ventilation system may suffice;
    c) Removal of a through-the-wall portable air conditioner, to examine the building envelope, drainage and the relationship between exterior/interior building materials; and
    d) Removal of a section of the steel exterior wall panels from an EC wall (preferably in a southwest facing corner of the building) to examine the building envelope, drainage and the relationship between exterior/interior building materials.
2. Remove or unearth all weep holes in exterior walls to maximize water drainage from exterior wall systems.
3. Remove wicks from all weep holes and clear obstructions to walls to maximize water drainage from exterior wall systems.

4. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control.
5. Repair and/or replace thermostats as necessary to maintain control of thermal comfort.
6. Examine each univent and AHU for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers school-wide.
7. Inspect rooftop exhaust motors and belts for proper function. Repair and replace as necessary.
8. Remove all blockages from univents, air diffusers and exhaust vents to facilitate airflow.
9. Thermostat settings throughout the complex should be evaluated. Thermostats should be set at temperatures to maintain comfort for building occupants.
10. Once both the fresh air supply and exhaust ventilation are functioning, the systems should be balanced by a ventilation engineering firm in accordance with Standard 111, SMACNA's HVAC Systems-Testing, Adjusting and Balancing, 2nd Edition.
11. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, implementation of scrupulous cleaning practices should be implemented. This will minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is

low. Use of vacuum cleaning equipment outfitted with a high efficiency particulate arrestance (HEPA) filter is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

12. Report any roof leaks or other signs of water penetration to building maintenance for prompt remediation.

13. Clean roof drain catches of debris to enhance rainwater drainage. Replace all missing/damaged drain catches to prevent drain clogs. Examine each roof drain for clogs and remove where found. Consider instituting roof inspections on a regular basis to examine catch basins for blockage.

14. Move plants away from univents in classrooms. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary.

15. Examine water-damaged carpeting for mold growth. Discard carpet if moldy. Ensure all carpet remnants and backing materials are removed. Disinfect areas beneath and around carpeting with an appropriate antimicrobial.

16. Seal areas around sinks to prevent water-damage to the interior of cabinets and adjacent wallboard. Disinfect areas of microbial growth with an appropriate antimicrobial as needed.

17. Replace the B321 cabinet with one that meets the standards set by the National Fire Protection Association (NFPA, 1996) for storage of flammable substances.

18. Obtain an acid resistant cabinet for storage of acids.

19. Operate chemical hood exhaust fans at all times that chemicals are present within the equipment. Do not use chemical hoods for storage of chemicals. Examine the integrity of chemical hood cabinets and ductwork that is water damaged.

20. Secure thermometers containing mercury. Consider discontinuing the use of such thermometers and disposing these materials in accordance with Massachusetts hazardous waste disposal laws. Replacements may be available as part of the Executive Office of Environmental Affair's mercury reduction/elimination initiative.

21. Obtain Material Safety Data Sheets (MSDS) for chemicals from manufacturers or suppliers. Maintain these MSDS' and train individuals in the proper use, storage and protective measures for each material in a manner consistent with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL, 1983).

22. Replace missing ceiling tiles and fill utility holes and wall cracks to prevent the egress of dirt, dust and particulate matter between rooms and floors.

23. Consider placing a water impermeable barrier beneath water coolers and fountains to prevent moistening of carpets.

24. Clean humidifiers/dehumidifiers as per the manufacture's instructions to prevent bacterial/microbial growth.

25. Prohibit smoking in the building in accordance with Massachusetts law (M.G.L. Chapter 270, Sec. 22).

26. Refrain from using strong scented materials in offices and restrooms.

27. Relocate or consider reducing the amount of materials stored in offices/classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.

28. Change filters for all air-handling equipment, air conditioning units and air purifiers as per the manufacturer's instructions or more frequently if needed. Vacuum interior of univents and AHUs prior to activation to prevent the aerosolization of dirt, dust and particulate. Ensure filters fit flush in their racks with no spaces in between allowing bypass of unfiltered air into the unit.

29. Clean chalkboards and chalk trays regularly to prevent the build-up of excessive chalk dust and dry erase marker particulate.

30. Enforce Massachusetts General Laws 90:16A requiring vehicles to shut off engines after five minutes to avoid the entrainment of vehicle exhaust into the school's HVAC system.

31. Consider developing a written notification system for building occupants to report indoor air quality issues/problems. Have these concerns relayed to the maintenance department/building management in a manner to allow for a timely remediation of the problem.

32. Evaluate science chemical flow hoods in order to determine proper function to contain vapors in accordance with ANSI/ASHRAE 110-1995 section 6.

33. Continue with plans to contact the school's contractor to shorten flexible ductwork to kiln vent to improve exhaust capabilities.

34. Encapsulate exposed fiberglass insulation around univents and pipes to avoid the aerosolization of fiberglass fibers.

The following **long-term** measures should be considered.

1. Based on the age, physical deterioration and availability of parts of the HVAC system, the BEHA strongly recommends that the HVAC engineering firm fully evaluate the ventilation system for repair/replacement considerations.
2. In order to remove moisture from curtain wall/drainage plane system penetrating into the univent fresh air intake hole, installing a duct connecting the fresh air intake grill to the base of each univent (see Figure 6) is recommended. The duct should be constructed of a material that is water/corrosion resistant and is installed in a manner to facilitate moisture drainage and drying of surrounding brickwork.
3. Repair and/or replace thermostats and pneumatic controls as necessary to maintain control of thermal comfort. Consider contacting an HVAC engineer concerning the repair and calibration of thermostats and pneumatic controls school-wide.
4. Repair/replace loose/broken windowpanes and missing or damaged window caulking building-wide to prevent water penetration through window frames.
5. Consider consulting a structural engineer/architect specializing in building envelope issues to examine the watertight integrity of metal paneling on the exterior of single-pitched rooftop structures containing skylights and seal/repair as necessary. Replacement or repair of both the roof and exterior wall systems should be examined by this consultant.
6. Examine the feasibility of installing local exhaust ventilation in teachers work rooms/offices.

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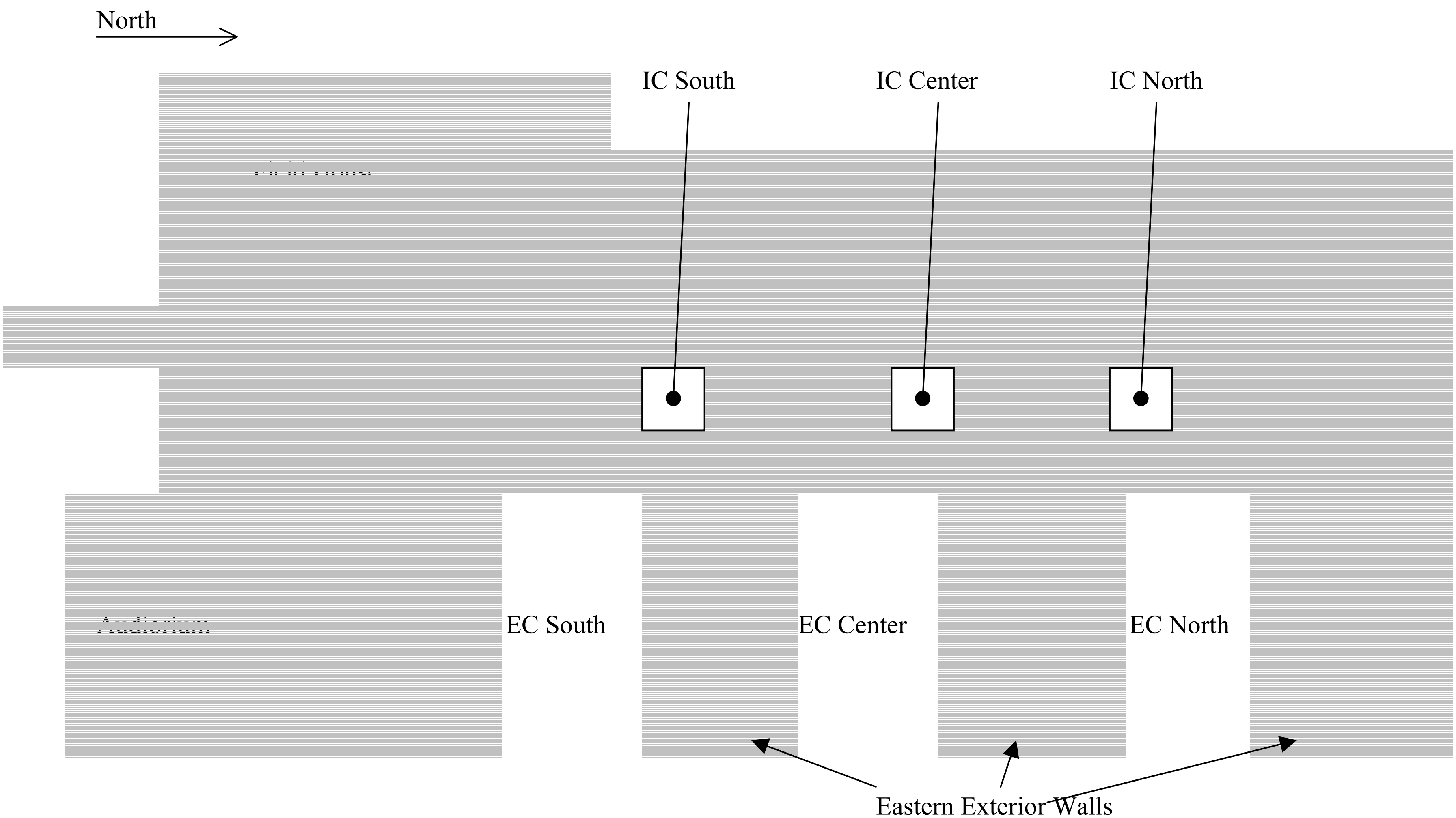
Figure 1
General Configuration of PVNHS Depicting Location of Courtyards



Drawing Not to Scale

Figure 3
The Function of the Drainage Plane and Weep Holes to Drain Water from the Wall System, Prevent Moisture Penetration into the Interior

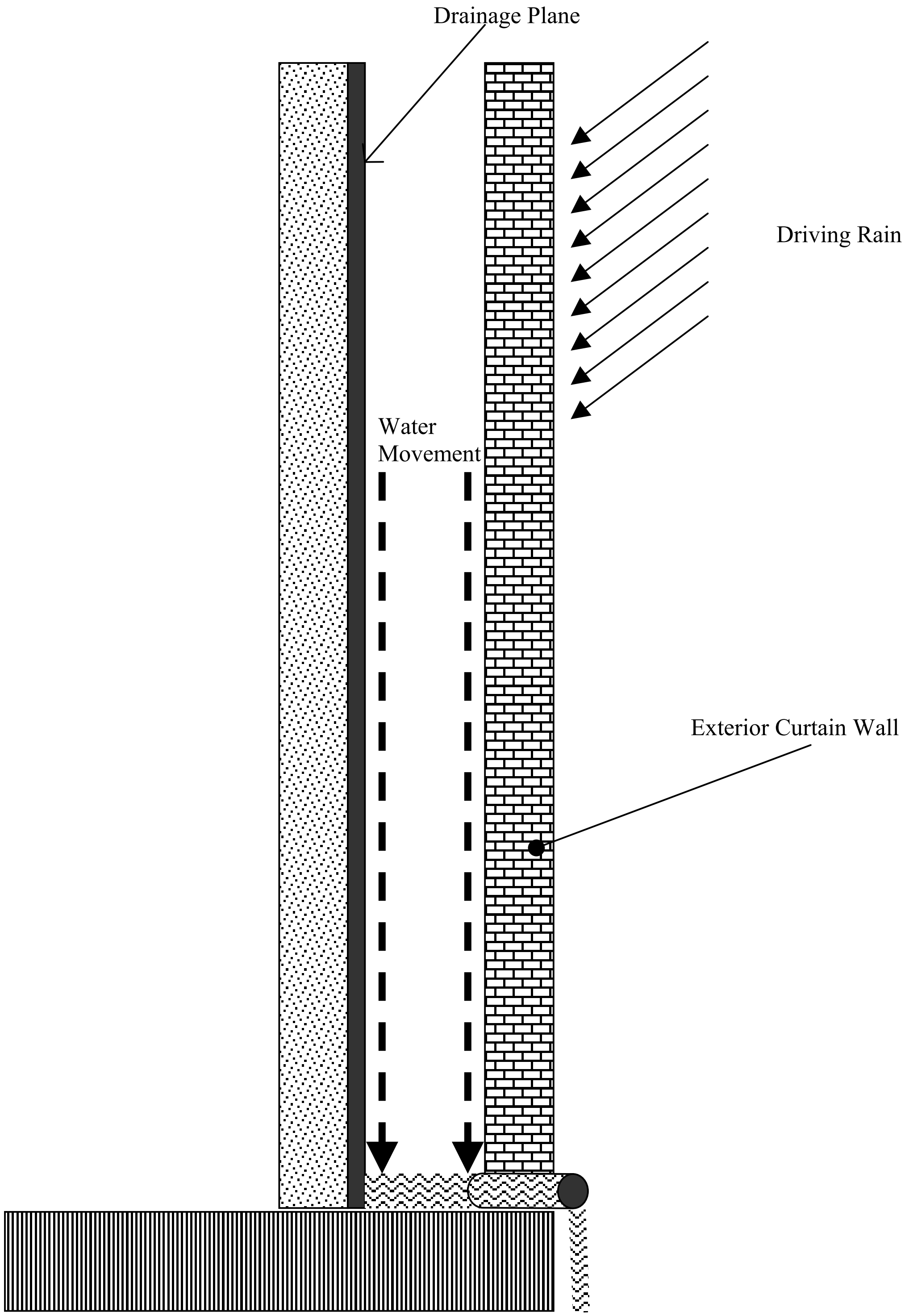


Figure 4
Weep Hole Blocked with Wick and Water Accumulation in the Drainage Plane

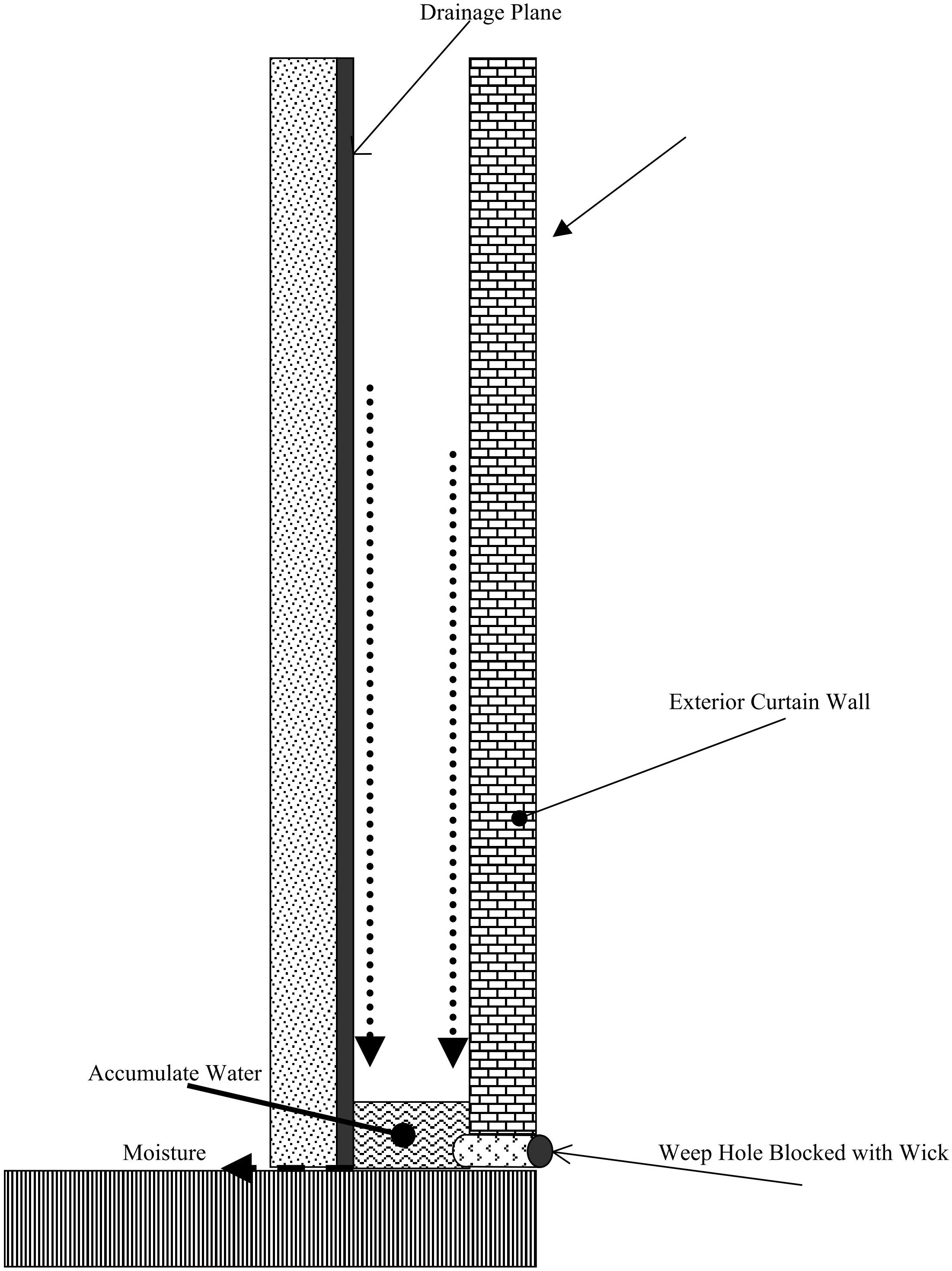


Figure 5
Draw of Moisture From Wall System Into Univent Fresh Air Intake Vent

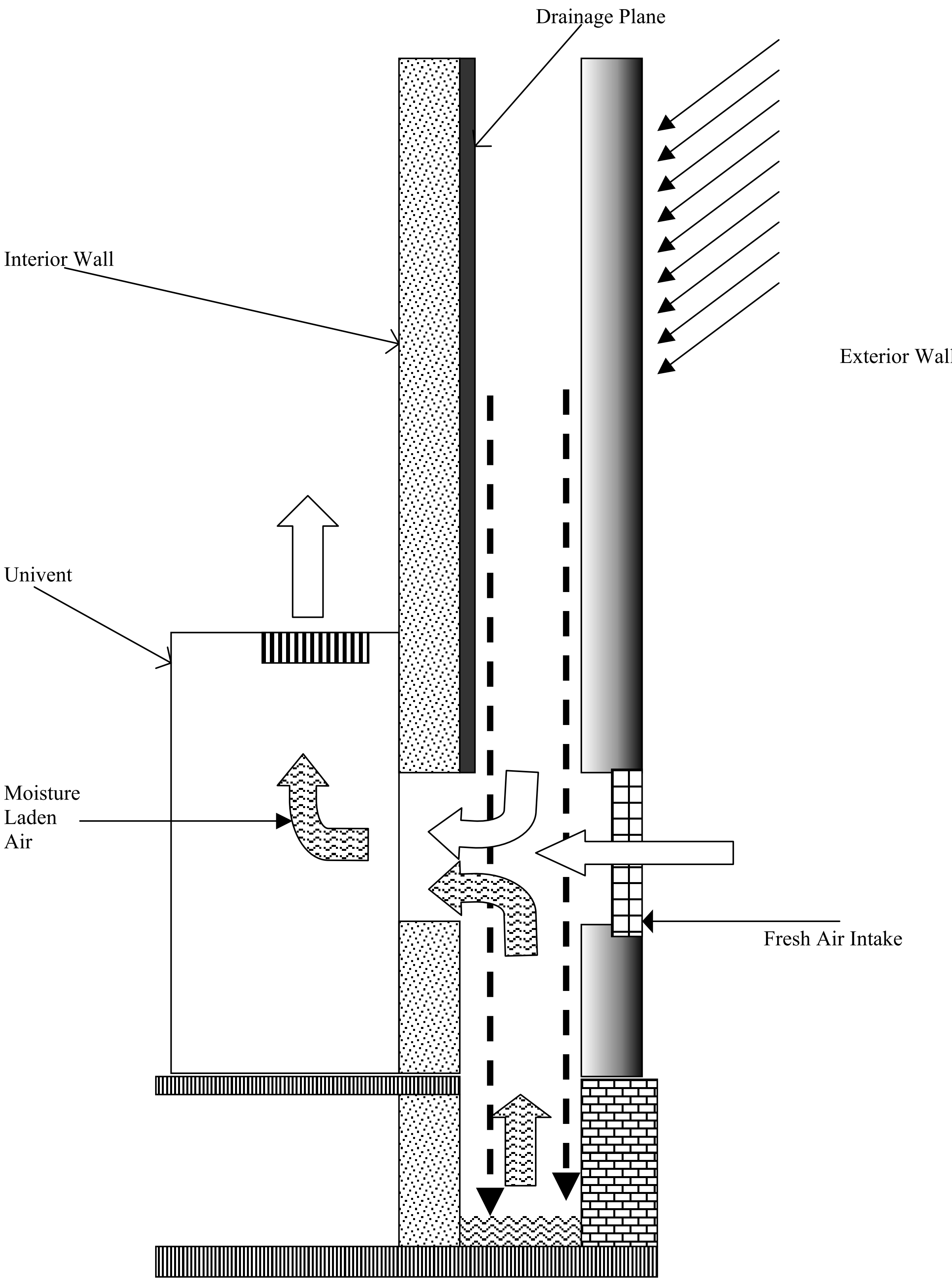
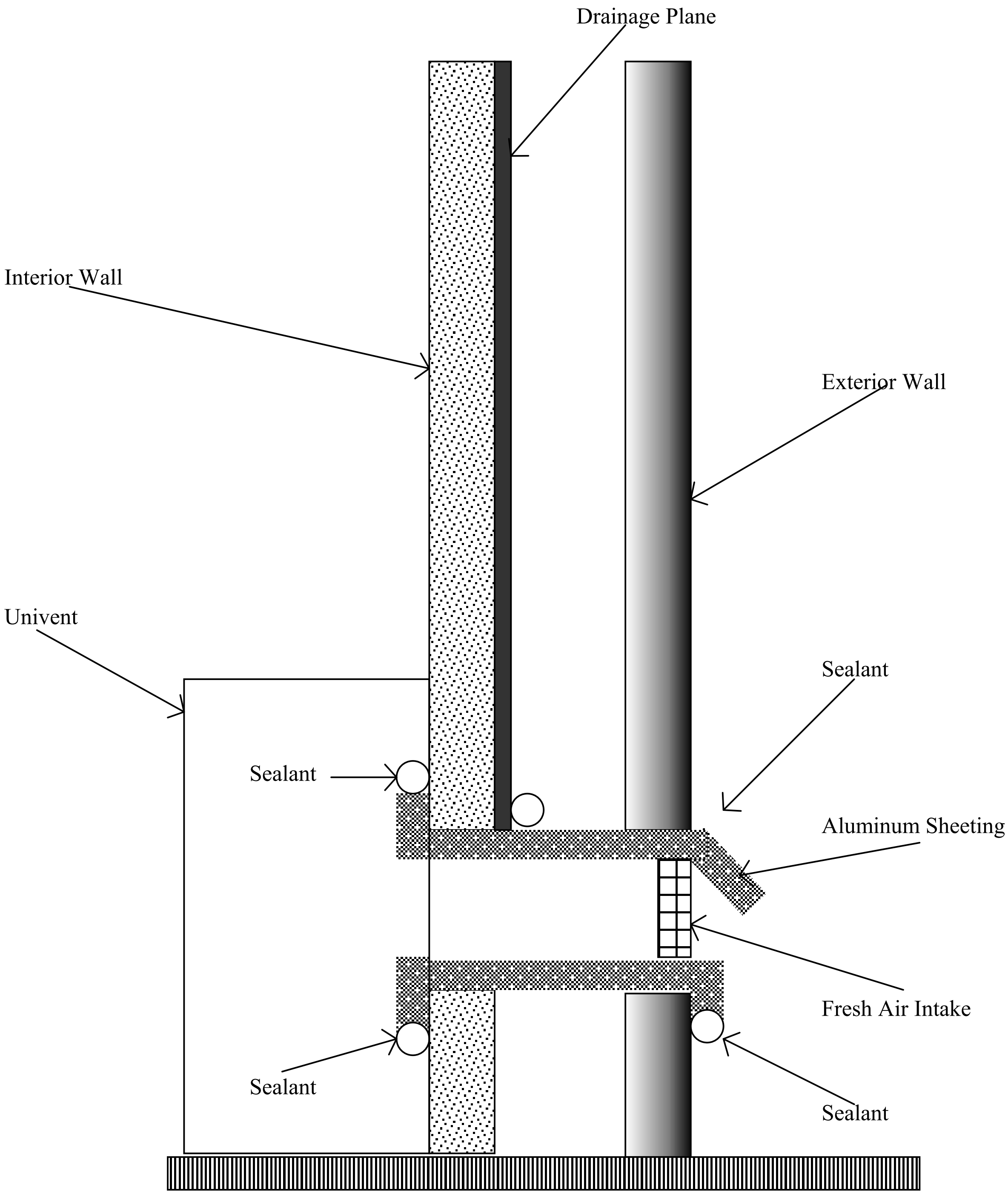


Figure 6
Sealing of Univent Fresh Air Intake Vent from Exterior Wall Drainage Plane



Picture 1

Univent With Plexiglass Replacing Original Fresh Air Diffuser Grilles; Note Size of Slots Compared with Picture 2

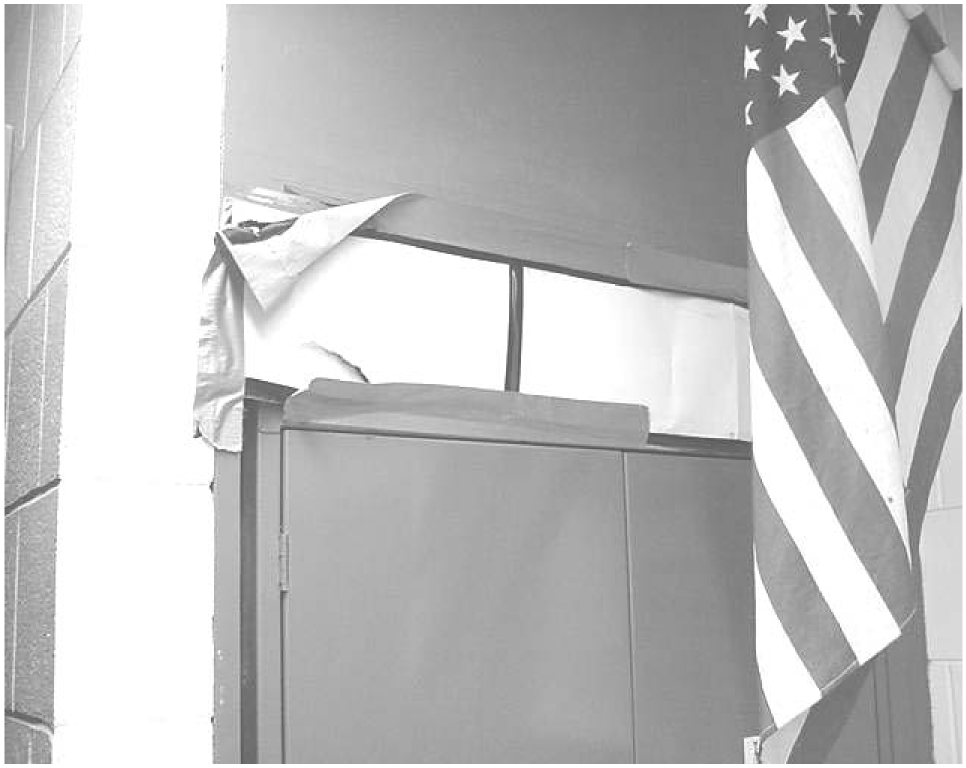
Picture 2

Univent With Original Fresh Air Diffuser Grilles

Picture 3

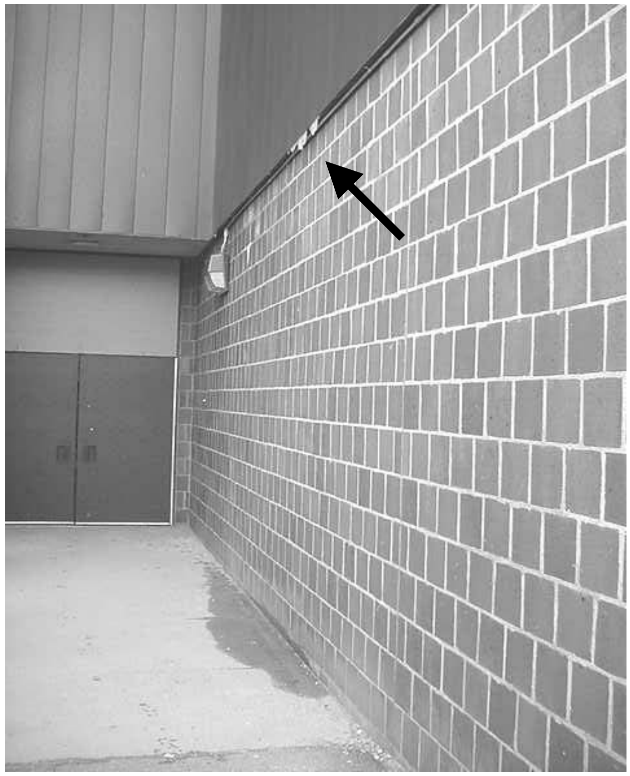
Slotted Exhaust Vents above Classroom Coat Closets

Picture 4



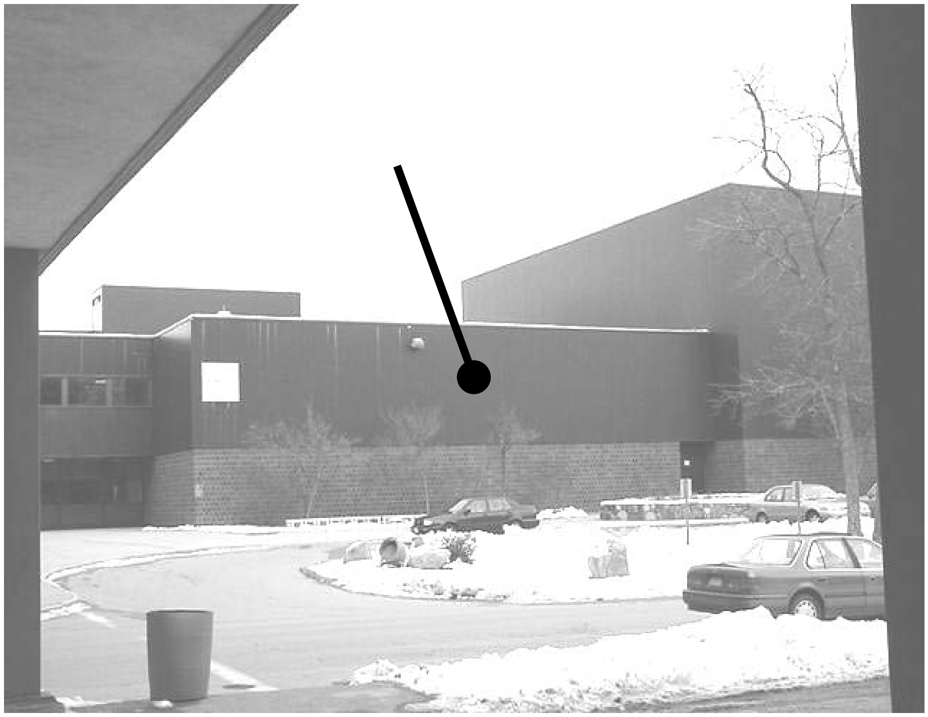
Classroom Exhaust Vent Sealed With Cardboard and Duct Tape

Picture 5



Brick Exterior Wall System of First Floor; Note Ice at the Base of the Steel Exterior Wall System Indicating Water Penetration

Picture 6

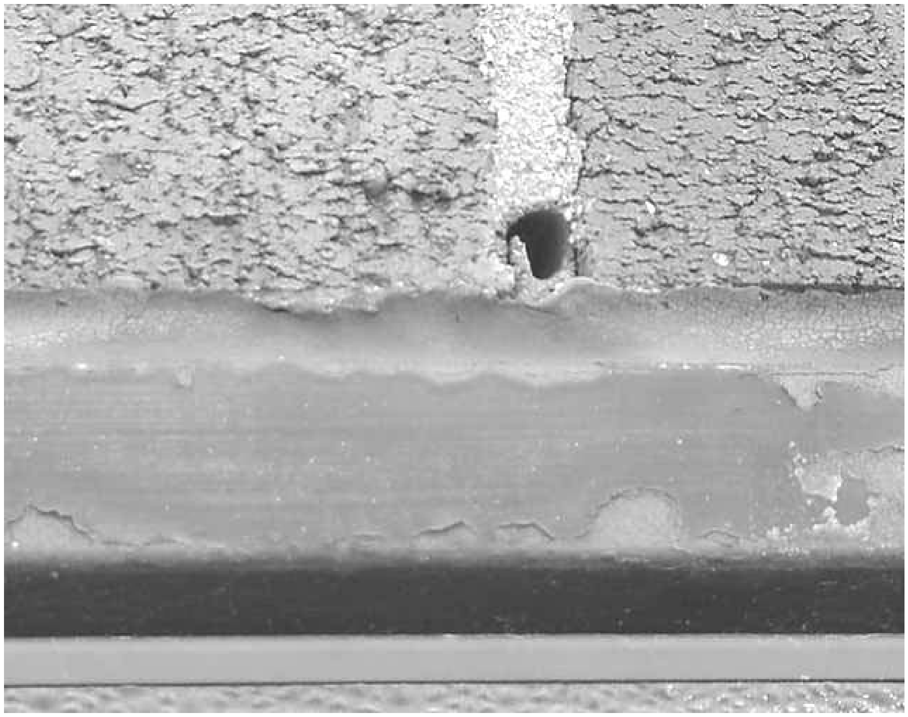


Metallic Cladding System of the Upper Floors That Rests On the First Floor Brick Curtain Wall

Picture 7

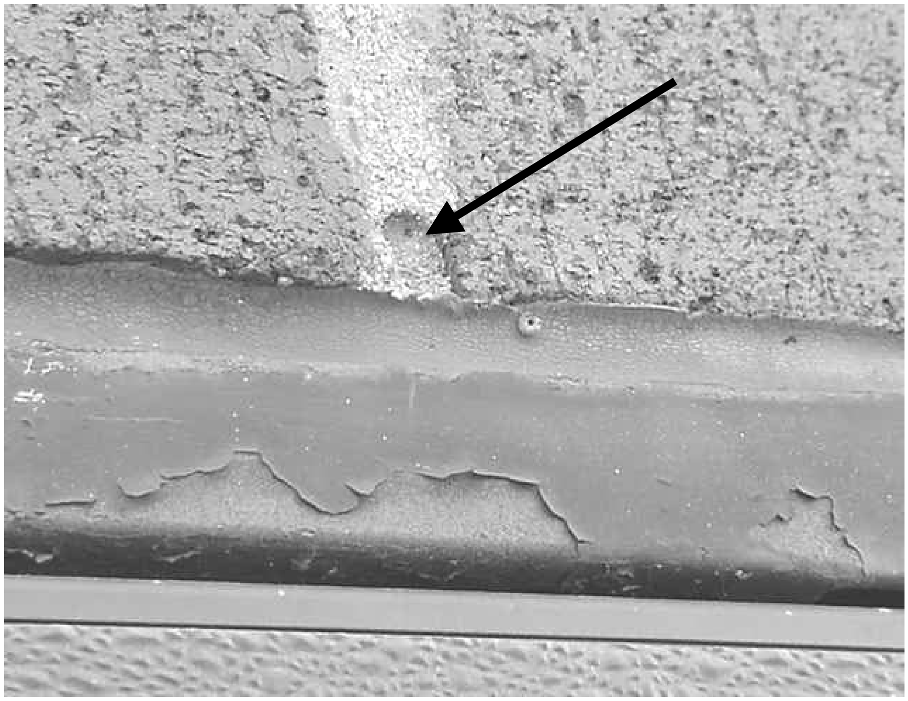
Damage From Water Penetration into the Exterior Brick Wall From Steel Exterior Cladding System

Picture 8



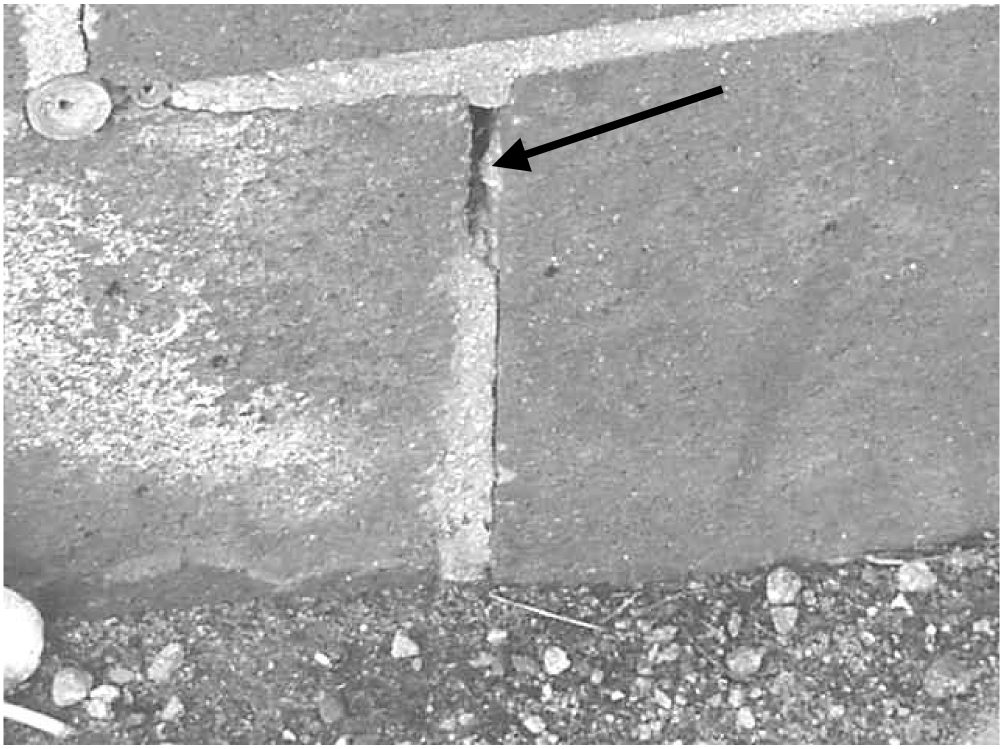
Example of Open Weep Hole; Located on the North and East Facing Exterior Walls

Picture 9



Typically Blocked External Wall Weep Hole

Picture 10



Field House Weep Holes

Picture 11

Western Exterior Steel Wall, Which Juts Out From The First Floor Exterior Wall; Note Buckling Of Wall System

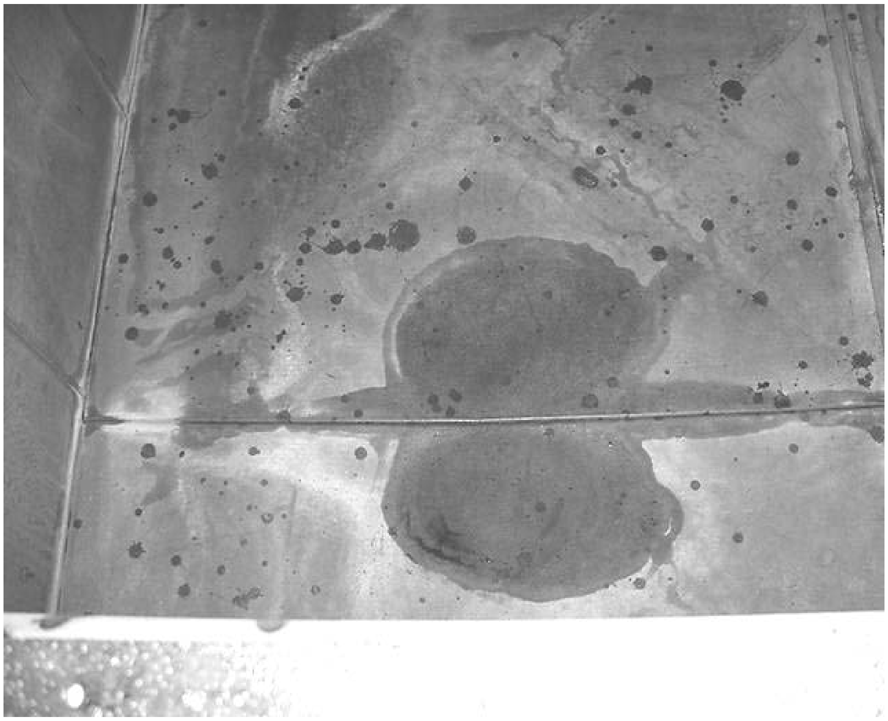
Picture 12

Dust On Floor of Room 243 Below Fresh Air Supply Vent

Picture 12A

Magnet Beneath Paper Holds Dust, Indicating Dust Contains Iron

Picture 13



**Floor of Air Handing Unit (AHU) That Draws Fresh Air from the Center ICY;
Note Accumulated Water, Which Appears To Enter the Duct through A Seam in the Floor's Sheet Metal**

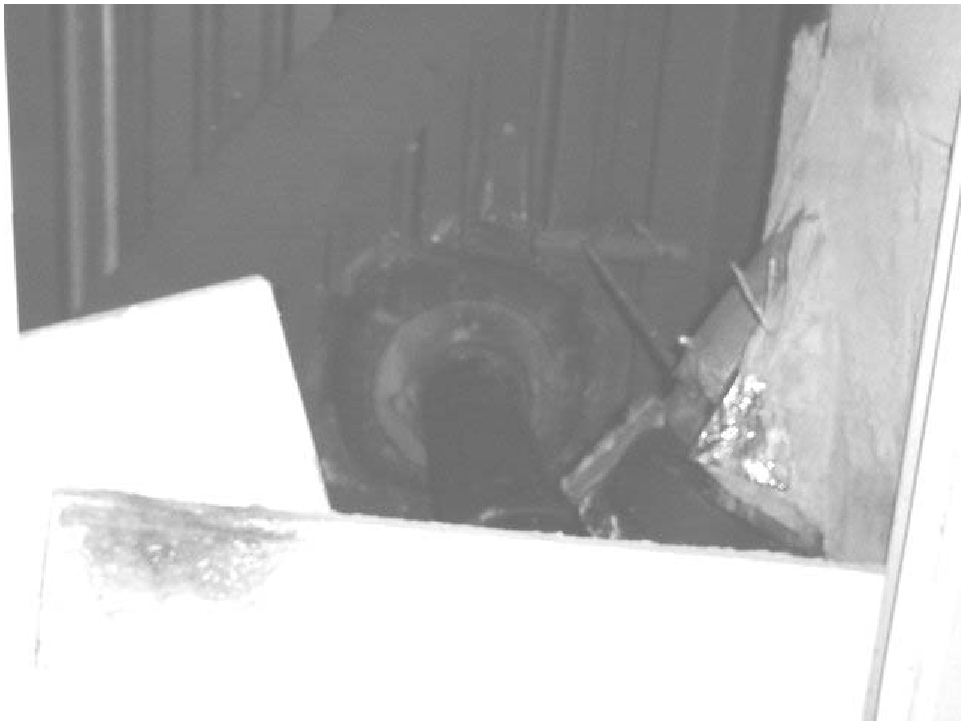
Picture 14

Fresh Air Intake for Duct Depicted in Picture 13; Note Moistened Brick around Center ICY On First Day of Assessment

Picture 15

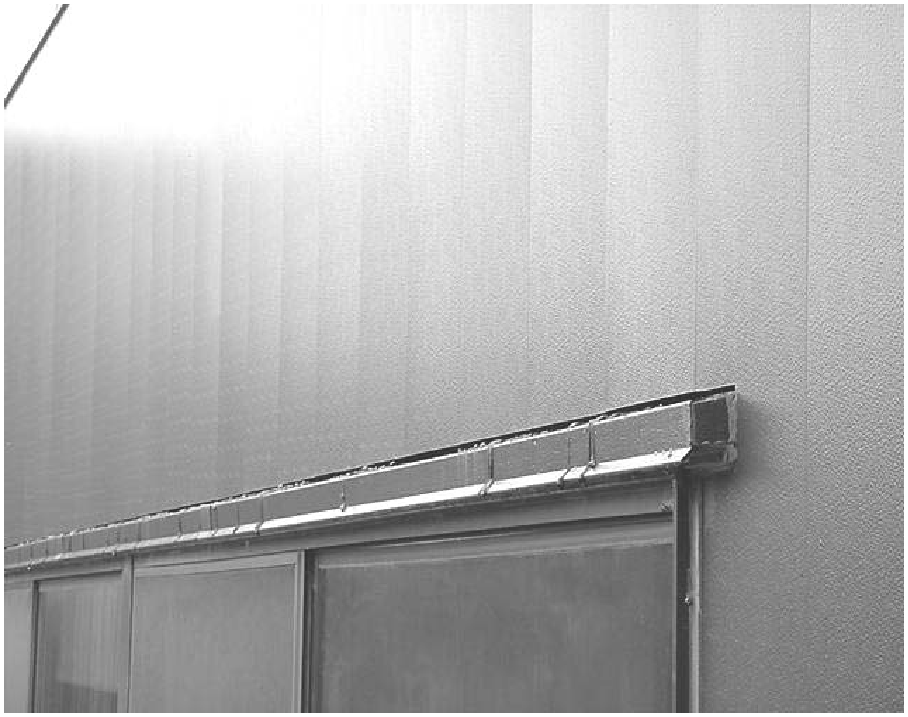
Water-Damaged Ceiling Tiles below Roof Drain in Classroom B-354
Dark Stains Indicate Possible Mold Growth

Picture 16



Roof Drain above Ceiling Tiles in Classroom B-354

Picture 17



No Gasket System Was Installed Along the Top of Window Frames

Picture 18

Broken Window Pane in Classroom

Picture 19

Ripped Window Screens in Classroom

Picture 20

Water-Damaged Windows in Classroom

Picture 21

Water Vapor between Window Panes

Picture 22

Splashing Water along the Edge of the Building Wets the Base of Exterior Walls Creating A Characteristic Stain

Picture 23

Plant Growth In/Around Univent Air Intake

Picture 24

Aquarium with Algae Growth

Picture 25

Univent Fresh Air Intake

AHU on Floor of South ECY Found to be Emitting Carbon Monoxide from an Exhaust Port; Note Fresh Air Intake

Picture 26

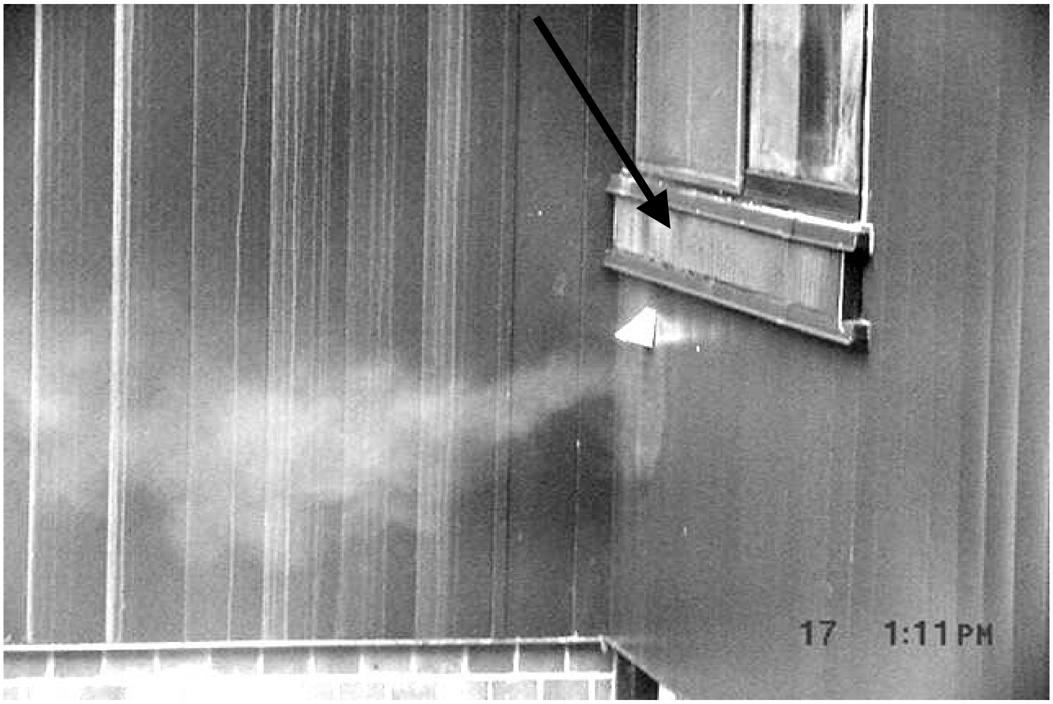
Private Vehicles Parked Beneath Air Intake; Note Sign Reads "Delivery Vehicles Only"

Picture 27

Household Fan Mounted In Window for Exhaust Ventilation

Picture 28

Univent Fresh Air Intake



Dryer Exhaust Vent Below Univent Air Intake; Note Water Vapor and Particulate during Operation

Picture 29

Flexible Ductwork for Pottery Kiln

Picture 30

Exposed Fiberglass around Classroom Univent

Picture 31

Indicator Lights on Wall-Mounted AC Unit Indicating Filters Are Saturated

Picture 32

Portable Air Purifier Occluded With Dust/Dirt

TABLE 1

Indoor Air Test Results – Peabody High School, Peabody, MA – January 15, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	401	43	33					
Faculty A	461	69	26	7	Yes	Yes	Yes	Window open, sink-stove-refrigerator combo, microwave
A329	695	70	27	12	Yes	Yes	Yes	
Career Counsel	841	71	29	0	No	No	No	Air purifier-on, carpet, accumulated items, door open
Records A	797	71	28	1	No	No	No	Photocopier, missing CT, door open
Counselor 2A	703	71	28	0	Yes	No	Yes	Carpet, HEPA air purifier-small plant on top
Counselor 1A	751	72	28	1	Yes	No	Yes	Carpet, air purifier, window and door open, complaints of headaches
Unit Director-Lobby	581	71	26	5	Yes	Yes	No	Humidifier-on, upholstered furniture, univent obstructed by bench
Director A	696	72	28	1	Yes	No	Yes	Carpet
B345	960	72	28	24	Yes	Yes	Yes	Window open, exhaust off-poss. backdraft, 2 plants

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Peabody High School, Peabody, MA – January 15, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
B Guidance	1108	72	27	0	No	No	No	2 water-damaged CT, photocopiers, accumulated items, air purifier-off, door open
B Lobby	649	72	26	3	Yes	Yes	No	Window open, 2 plants
B Director's Office	988	71	28	1	Yes	No	Yes	Upholstered furniture, carpet, photocopier, plant
B Conference Room	670	71	27	0	No	Yes	Yes	Supply-off, carpet
B363	694	72	27	16	Yes	Yes	Yes	Window open, chalk dust
B347	1225	71	33	19	Yes	Yes	Yes	Univent-off, air purifier-on, window and door open
B344	885	71	29	19	Yes	Yes	Yes	Exhaust-off, air purifier-on filter saturated with dirt/dust, window and door open
B354					Yes	Yes	Yes	Roof drain-repeated leaks, stained CT, old CT above plenum, window open
Hallway (outside B353/354)								Stained CT near exit sign

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 3

Indoor Air Test Results – Peabody High School, Peabody, MA – January 15, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
A328	1085	75	32	27	Yes	Yes	Yes	Air purifier
A327	661	74	26	16	Yes	Yes	Yes	Window and door open, broken window, air purifier, flowering plant/paper on univent
A326	1265	72	31	25	Yes	Yes	Yes	Flowering plant on univent, air purifier, door open
A325	762	72	29	9	Yes	Yes	No	Exhaust in adjacent office, window and door open
A324	890	73	29	21	Yes	Yes	Yes	Cologne/perfume odors, air purifier
A323	1206	73	30	27	Yes	Yes	Yes	Air purifier, window open
A321	510	73	25	0	Yes	Yes	Yes	Window open
A320	1049	72	30	20	Yes	Yes	Yes	Books on univent, air purifier, door open
A319	1110	72	31	26	Yes	Yes	Yes	2 broken windows, door open
B362	684	71	27	14	Yes	Yes	Yes	Chalk dust

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – Peabody High School, Peabody, MA – January 15, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
B361	1100	71	30	17	Yes	Yes	Yes	Exhaust off, 1 water-damaged CT, air purifier
B360	610	72	27	0	Yes	Yes	Yes	Exhaust not functioning
B359	613	70	25	1	Yes	Yes	Yes	Door open
B358 (computer room)	663	73	27	0	Yes	Yes	Yes	~30 computers, missing CT, condensation between window frames
B357	780	73	26	22	Yes	Yes	Yes	Window and door open
B356	1154	73	30	25	Yes	Yes	Yes	Window open
B355	1500	71	31	21	Yes	Yes	Yes	Exhaust vent in adjacent office-passive door vent blocked by fan
B354	1155	71	31	28	Yes	Yes	Yes	Window and door open, air purifier-on, chalk dust
B353	1247	76	31	20	Yes	Yes	Yes	Exhaust vent in adjacent office, water-damaged/dislodged CTs, door open

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 5

Indoor Air Test Results – Peabody High School, Peabody, MA – January 15, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
A318	1025	71	32	21	Yes	Yes	Yes	Exhaust-very weak/off, window open, condensation between window frames
A317	1260	73	33	18	Yes	Yes	Yes	Exhaust-very weak/off
A316	901	69	30	21	Yes	Yes	Yes	Exhaust vent sealed with cardboard & duct tape, air purifier-on, window and door open-fan in window-on, double occupied
A315	527	69	28	0	Yes	Yes	Yes	Univent not functioning-(on "high"-no air flow), window open
B350	780	71	30	17	Yes	Yes	Yes	Plant
A314	1230	72	31	17	Yes	Yes	Yes	
A315	1105	67	35	13	Yes	Yes	Yes	Univent deactivated-fans placed at hallway door & window for airflow, window open
A312	894	72	37	24	Yes	Yes	Yes	Accumulated items, chalk dust
B351	785	70	30	28	Yes	Yes	Yes	Window and door open

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 6

Indoor Air Test Results – Peabody High School, Peabody, MA – January 15, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
B349	560	71	28	1	Yes	Yes	Yes	Complaints of vehicle exhaust odors, door open
B348	1200	70	33	12	Yes	Yes	Yes	Exhaust vent in adjacent office, window open, chalk dust
C397	1235	70	31	24	Yes	Yes	Yes	Air purifier-on
C396	1020	71	31	7	Yes	Yes	Yes	Air purifier-off, chalk dust, personal fan
C Lobby	773	71	29	5	Yes	Yes	No	Univent blocked by bench
Crisis Counsel	1011	72	30	3	No	No	No	Carpet, door open
C Records	754	72	27	0	No	No	No	Door open, photocopier
C Director’s Office	1055	73	28	1	Yes	No	Yes	Carpet, photocopier, door open
C Conference Room	716	74	26	1	No	Yes	Yes	Supply off, air purifier, 2 personal fans, carpet, refrigerator
C399	535	71	24	7	Yes	Yes	Yes	Books/cleaning product on univent, window open

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 7

Indoor Air Test Results – Peabody High School, Peabody, MA – January 15, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
C398	1124	72	29	22	Yes	Yes	Yes	Window and door open, books/coats on univent, air purifier-on, accumulated items, chalk dust
A311	752	72	28	12	Yes	Yes	Yes	Personal fan, condensation between window frames, chalk dust
Costa Office	823	70	28	0	No	No	No	Air purifier, accumulated items, complaints of headaches/breakouts
A313	1269	71	31	28	Yes	Yes		Condensation between window frames, air purifier-off, chalk dust
B352	999	70	30	19	Yes	Yes	Yes	Window open, air purifier-on, personal fan, plant, condensation between window frames
B350	601	70	27	0	Yes	Yes	Yes	2 air purifiers-on, 2 personal fans, chalk dust
C395	888	71	29	9	Yes	Yes	No	Air purifier-off
C382	721	69	29	0	No	Yes	Yes	Ceiling vents(5)-sounds like they're running-no air movement, air purifier, door open

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 8

Indoor Air Test Results – Peabody High School, Peabody, MA – January 15, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
C381	1453	70	30	25	Yes	Yes	Yes	Exhaust weak, door open
C380	1654	71	34	22	Yes	Yes	Yes	Air purifier-off, personal fan, chalk dust
C387	1922	72	33	22	Yes	Yes	Yes	Supply off, air purifier, personal fan, door open, damaged window screens, chalk dust
C388	851	71	28	19	Yes	Yes	Yes	2 plants on univent, air purifier-off, chalk dust
Cafeteria	1478	72	34	~600	No	Yes	Yes	6 out of 7 univent on, bowed CT, door open
Early Childhood	693	71	29	0	No	Yes		Books blocking supply, sinks, elec. stove, accumulated items, air purifier-off, exhaust off
C393	1074	74	28	1	Yes	Yes	Yes	Books on univent, personal fan, carpet, door open, window-condensation, complaints of headaches, exhaust off/very weak
C392	822	72	27	6	Yes	Yes	Yes	Air purifier, window-condensation, exhaust off/very weak, door open

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 9

Indoor Air Test Results – Peabody High School, Peabody, MA – January 15, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
C394	2084	72	34	19	Yes	Yes	Yes	Window and door open, window-condensation, exhaust off/very weak, dry erase board, chalk dust
C391	1132	74	29	23	Yes	Yes	Yes	Books on univent, exhaust off/very weak, window-condensation, air purifier, door open, dry erase board
A307	835	74	28	26	Yes	Yes	Yes	HEPA filter air purifier-on, window and door open
A308	1107	74	30	22	Yes	Yes	Yes	Air filter-off, chalk dust
Girl's Restroom					No		Yes	Passive door vent (supply), floor drain
C383	744	69	28	15	Yes	Yes	Yes	Window and door open, air purifier, personal fan, chalk dust
C390	543	69	28	0	Yes	Yes	Yes	Window open, personal fan, carpet
C389	874	72	30	29	Yes	Yes	Yes	Exhaust weak, door open
C384	846	73	30	19	Yes	Yes	Yes	Exhaust weak, damaged/missing window screens

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 10

Indoor Air Test Results – Peabody High School, Peabody, MA – January 15, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
C385	1087	73	30	12	Yes	Yes	Yes	Air purifier-off, door open
C386	918	72	28	17	Yes	Yes	Yes	Window and door open, broken window-damaged screen, water-damaged CT, chalk dust, complaints-sinus/respiratory problems

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 11

Indoor Air Test Results – Peabody High School, Peabody, MA – January 17, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Outside (Background)	365	44	37					Weather conditions: light snow, cold, overcast
Library - (Main Area)	423	69	25	10-15	Yes	Yes	Yes	Univent return blocked by carts, 3 water-damaged CT (south reference area)
Storage Room	566	71	24	0	Yes	No	No	
Library - Break Room	440	71	24	0	No	No	No	No mechanical ventilation, no passive vents
Library Office	451	72	22	0	No	Yes	Yes	Passive intake, door open
Library – Circulation Desk	477	72	23	6	Yes	Yes	Yes	
Library – Audio/Visual Room	444	75	22	0	No	Yes	Yes	Holes in wall/floor, gutter downspout on wall-empties into bucket on floor, water stains-exterior wall, water-damaged/broken CTs, supply and exhaust off, water-damaged curtains, network to school computer system, accumulated items-boxes/old computer systems

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 12

Indoor Air Test Results – Peabody High School, Peabody, MA – January 17, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
C277	651	74	25	17	Yes	Yes	Yes	21 computers, exhaust off, door open, sink doesn't work
C272	1110	70	28	16	Yes	Yes	Yes	18 computers, exhaust off
C271	552	72	25	0	Yes	Yes	Yes	Door open
Business Office	656	72	25	1	No	No	Yes	Air purifier, no passive vent/undercut, no heat/air conditioning-temperature complaints
Business Storage				0	No	No	No	Water stains on wall
B233	713	70	27	18	Yes	Yes	Yes	Window open, aquarium, air purifier, damaged paint-corner
C265	984	71	29	15	Yes	Yes		Air purifier
C266	657	71	27	9	Yes	Yes	Yes	Air purifier-on, door open
C – P&A	605	75	26	1	Yes	Yes	Yes	Carpet, wall-mounted air conditioner, accumulated items, door open, complaints-tired/difficulty thinking

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 13

Indoor Air Test Results – Peabody High School, Peabody, MA – January 17, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
C267	468	70	24	0	Yes	Yes	Yes	Air purifier-on, door open
C281	649	72	26	6	Yes	Yes	Yes	2 plants, spray cleaner on univent, door open
Photo Lab							Yes	Exhaust-switch activated, door open
A204	1005	71	27	16	Yes	Yes	Yes	Exhaust very weak/off, door open, air purifier-on, 2 plants, aquarium
B230	1276	71	30	19		Yes	Yes	Exhaust weak, air purifier-off, door open, complaints-headaches
B235	736	70	26	2	No	Yes	Yes	2 chemical vent-hoods-items stored inside, 9 water-damaged CT, door open
Chemical Storage – Biology					No	Yes	Yes	Supply/exhaust-off, flammables cabinet, overcrowded shelves, 3 water-damaged CT, 1 broken CT, 2 doors open
B231	994	70	29	14	Yes	Yes	Yes	Air purifier
B234	664	69	27	0	No	Yes	Yes	Exhaust off, 2 chem.vent hoods, 7 sinks, spray cleaner on sink

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 14

Indoor Air Test Results – Peabody High School, Peabody, MA – January 17, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
B - P&A	641	71	28	0		Yes		Univent blocked by books/cart, refrigerator, sink, elec. stove, door open
B232	838	70	28	22	Yes	Yes	Yes	Air purifier-on, 1 bowed CT, door open, dry erase board
A327	1026	69	33	11	Yes	Yes	Yes	Plant/paper on univent, window open, broken window-condensation, wall cracks, accumulated items, 3 CT ajar, air purifier, personal fan, chalk dust, temperature complaints
Auditorium	485	72	24	15	No	Yes	Yes	Carpet ~3 yrs. Old, spaces under exterior door, chalk dust
Large Band Room	519	65	23	0	No	Yes	Yes	Water damaged ceiling, exterior door, dry erase board, chalk dust, bleach under sink
Small Band Room	655	67	30	9	No	Yes	Yes	Chalk dust, door open
A201	872	69	29	18	Yes	Yes	Yes	Exhaust very weak/off, personal fan, chalk dust, sink
A202	777	70	29	18	Yes	Yes	Yes	Air purifier, door open, chalk dust

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 15

Indoor Air Test Results – Peabody High School, Peabody, MA – January 17, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
A203	909	71	28	16	Yes	Yes	Yes	Window and door open, chalk dust, air purifier
Prep Center Classroom – (used evenings only)	478	70	27	0	Yes	Yes	No	8 computers, soda machine, photocopier, door open
Prep Center Office	587	71	28	1	Yes	No	Yes	Desk cleaners, door open, dry erase board, personal fans, complaints-temperature extremes
Athletic Director	765	73	30	1	Yes	No	No	Photocopier, carpet, personal heater, wall-mounted air conditioner, cleaning product/coffee on refrigerator, fan coil unit
Gym	594	70	27	8	No	Yes	Yes	Space under exterior door
B241	690	69-74	29	6	Yes	Yes	Yes	Window and 2 doors open, air purifier-on, complaints-room "stuffy", sinus infections, watery eyes, irritated throat, temperature extremes (temp. directly over univent-129º F), sink, irons

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 16

Indoor Air Test Results – Peabody High School, Peabody, MA – January 17, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Administrative Assistant to Principal – Office	829	74	27	0	No	No	No	Door open, floor fan-on, personal fan, air purifier-both indicator lights on-filter occluded, humidifier
Principal's Office	686	73	26	0	Yes	Yes	Yes	Carpet, supply off, asthma/bronchitis
Assistant Principal's Office	718	71	26	0	Yes	Yes	Yes	Carpet, personal fan, dry erase board
Women's Staff Restroom					No	No	Yes	Hair spray, air freshener spray
Bus Ramp	967	72	30	20	Yes	Yes	Yes	Supply and exhaust off, air purifier, personal fan, peeling paint, dry erase board, chalk dust, window open
Suspension Room	1107	73	31	9	Yes	Yes	No	Windows-condensation
Office (Prep Center)	685	72	26	0	Yes	No	No	Accumulated items-books

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 17

Indoor Air Test Results – Peabody High School, Peabody, MA – January 17, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
B243 Art Room	695	71	30	1	Yes	Yes	Yes	~18 occupants gone 15 mins., 3 water-damaged CT-over window, spray booth-new filter, supply blocked by cart/items on top, exhaust off, air purifier
C270	499	73	27	0	Yes	Yes	Yes	Exhaust vent in "balcony"-air drawn over ½ windows, carpet, 8 computers, missing CT
B237	605	70	27	11	Yes	Yes	Yes	Exhaust off, CT ajar, spray booth, 2 plants, accumulated items, clay items on univent, window open, dust, ceiling-mounted Clean Air System 90175
Consumer Science Workroom	593	71	27	1	No	No	Yes	Photocopier
Consumer Science Office	604	71	27	1	No	Yes		Carpet, accumulated items, passive door vent (exhaust), water-damage in hall
B239	822	72	30	17	Yes	Yes	Yes	Gas/elec. stoves, cleaning products under sink, door open, food
Copier Room	766	69	28	3	Yes	No		Window and door open, exhaust fan in window, 6 photocopiers

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 18

Indoor Air Test Results – Peabody High School, Peabody, MA – January 17, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Home Ec. Office	618	68	27	0	No	No	No	Air purifier, personal fan, photocopier
B240 Kitchen	512	68	29	0	Yes	Yes		Large gas stove-with exhaust hood, window open, utility holes
English Office	624	71	28	1	No	No	Yes	Door undercut
Social Studies Office	570	72	28	1	No	No	Yes	Door undercut
Science Office	565	72	26	0	No	No	Yes	Door undercut, thermostat for adjacent office-set to "auto"
Guidance Supervisor	657	73	27	2	No	No	No	Photocopier
SpEd Main Office	558	74	25	0	No	No	Yes	Exhaust off
Kiln Room								Turns in flex-duct, kiln odors, corrosion on CT runners, check motor
Main Office	646	69	27	8	Yes	Yes	Yes	1 out of 2 exhaust vents off, water-damaged CT above univent, temperature complaints, water cooler on carpet

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred 600 - 800 ppm = acceptable > 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 19

Indoor Air Test Results – Peabody High School, Peabody, MA – January 17, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Student Records Office	722	71	26	0	No	No	Yes	3 photocopiers, univent off, window-mounted fan, water-damaged CT
Main Office Restroom						No	Yes	No passive vent, slight undercut
Math Office	515	71	26	0	No	No	Yes	No airflow, exhaust off
IBM Network Server Room	661	70	28	3	Yes	Yes	Yes	No air conditioning/network equipment, accumulated items, temperature complaints (heat)
Conference Room				0	No	No	No	Missing CT-wiring, space between sink/backsplash
Land Department Head Office	645	72	26	0	No	No	No	No door vent/undercut, air purifier-dusty filter
B242	700	70	29	11	Yes	Yes	Yes	22 computers, no air conditioning-temperature complaints (heat), little airflow, electrical odors
C270	407	73	24	0	Yes	Yes	Yes	Exhaust vent in control booth-not lab

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 20

Indoor Air Test Results – Peabody High School, Peabody, MA – January 17, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
B243	699	72	28	15	Yes	Yes	Yes	Univent blocked/covered by items, spray booth, door open, exhaust vent in storage closet-occluded with dust, water damaged CTs along windows
Woodshop	519	70	20	0	No	Yes	Yes	General exhaust, door open, saw dust-large accumulation in univent, univent making noise, alcohol/turpentine in metal cabinet, passive vent over door to hallway, open cans of polyurethane/stains, wood dust collection system, piles of sawdust/fine dust covering all machines/flat surfaces
Cosmotology	749	73	23	~10	No	Yes	Yes	Broken windows, acteone odors, chalk dust, food, area carpet
Locker Room								2 wall vents-no airflow, water damage
Store Room								Hairsprays, gels, baby powder, etc.
Office	792	72	23	0	No	No	Yes	Sink-bleach/accumulated items under, 2 doors open, computer

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 21

Indoor Air Test Results – Peabody High School, Peabody, MA – January 17, 2002

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 22

Indoor Air Test Results – Peabody High School, Peabody, MA – January 18, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Outside (Background)	324	33	46					
C269 Flammable Locker								Containers with rubber/cork stoppers, vintage materials, corroded metal containers, overcrowded shelves, food products in flammables cabinet
B235								Old flammables cabinet—asbestos lined, corroded, fortified shelves, missing CT-no working exhaust vent, water damaged CT, unlabeled beakers-stoppered with cotton, cabinets left open
A205 Chemical Storage								2 unsecured gas cylinders, materials identified by chemical formula vs. name, cork stoppers, flammables cabinet-cork/glass stoppers
School Resource Office (1st floor)	648	73	23	1	No		Yes	Passive vent over door, wall vent with fan switch, ceiling fan, partial carpet, dry erase board

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 23

Indoor Air Test Results – Peabody High School, Peabody, MA – January 18, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Women's Restroom (1st floor)							Yes	Odors, floor drain-water
Stage Area	495	71	19	0	No			Door open to costumes/sets area-sawdust, wood, paints/varnishes, table saw, other accumulated items, active leaks near stage (2nd row center), acoustic CT-filth/debris,
Small Band/Chorus Room	885	68	23	~40	No			
Music Office	831	71	24	1	No		Yes	Air purifier, refrigerator
School Store	537	69	20	5	No	Yes	No	Univent off, missing CT-exposed fiberglass, carpet, temperature complaints, door open, passive wall vent to bank
School Bank	1032	72	24	11	No	Yes		Supply off, passive wall vent to store, photocopier, personal fan, door open
B111	623	72	22	0	No	Yes	Yes	Exhaust weak, air purifier, chalk dust, plant

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 24

Indoor Air Test Results – Peabody High School, Peabody, MA – January 18, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Planetarium								Carpet
Coffee Shop	1080	75	24	~20	No	Yes	Yes	3 water damaged CT,
B107	997	75	22	12	No	Yes	Yes	Exhaust very weak/off, 4 plants-1 on paper towel, electric stove, accumulated items
A328				1	Yes	Yes	Yes	Reports of occasional odors-directly below series of vent pipes/on courtyard, reports of water from univent
Hallway outside A328 (rear)								Large space/hole in roof access door
Spec Head Office (library)	792	74	22	6	No	Yes	Yes	Passive door vent, exhaust off, door open
C281	673	72	23	10	Yes	Yes	Yes	Hole in wall next to univent-draft, door open
C279	441	72	22	0	Yes	Yes	Yes	Univent off-reportedly does not work, wall-mounted air conditioner-dirty filter, exhaust off
TV Studio	448	64	23	0	Yes	Yes	Yes	Window open

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 25

Indoor Air Test Results – Peabody High School, Peabody, MA – January 18, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
TV Control Room	421	68	25	0	No	Yes	Yes	Missing CT-exposed fiberglass, dust accumulation on surfaces, accumulated items
TVST	564	70	26	11	Yes	Yes	Yes	Missing CT-exposed fiberglass, holes in CT-formerly for wiring, exhaust in adjacent office
Dark Room					No	No	Yes	Paint thinner on shelf
C280		70	26	13	No	Yes	Yes	Water-damaged CT in corner, missing CT-active leaks around ductwork-bucket below leak, items on univent
Photo Lab Darkroom				0	No	Yes	Yes	Spaces around sink-backsplash, standing water under sink, passive intake
Electric Room 22					No	Yes	Yes	Water-damaged CT, hole in CT, missing CT, exposed fiberglass, fire detector hanging from ceiling
Custodian 22					No	Yes	Yes	
C275	731	79	25	13	Yes	Yes	Yes	14 computers, no air conditioning, dislodged CT

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 26

Indoor Air Test Results – Peabody High School, Peabody, MA – January 18, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
C274	808	74	23	14	Yes	Yes	Yes	18 computers, no air conditioning
C276	541	72	25	7	Yes	Yes	Yes	Water damaged CT along wall, door open
C273	438	77	23	1	Yes	Yes	Yes	Electrical odor from univent, abandoned sink, reported periodic odors
Nurse's Office	768	72	23	3	No	Yes	No	Rash, metallic smell/taste
Boy's Recovery	786	72	23	1	Yes	Yes	Yes	
Girl's Recovery	761	73	22	0	Yes	Yes	No	
Exam Room	987	76	23	0	No	Yes	No	Poor lighting
Old Dish Room								Abandoned dishwasher, floor drain capped/clogged
Pre-School								CT replaced-(mold growth due to condensation), pipes re-wrapped
Culinary Arts (former metal shop)	402	70	20	3	Yes	Yes	Yes	Existing vent hoods against wall-ranges/fryers ~5-10 ft. from vent hoods along perimeter

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 27

Indoor Air Test Results – Peabody High School, Peabody, MA – January 18, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Planetarium	425	76	15	0	No	Yes	Yes	Dusty, seldom used
Culinary Arts Kitchen	609	71	22	6	Yes	Yes	Yes	Water damaged CTs
Culinary Arts Storeroom	370	62	19	0	No	No	No	Holes in ceiling (burst pipe), heater installed to prevent cold drafts

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 28

Carbon Dioxide Air Monitoring Results Comparing January 17, 1997 to January 15, 17-18, 2002
Peabody Veterans Memorial High School, Peabody, MA

Location	Carbon Dioxide	Occupants In Room	Carbon Dioxide	Occupants In Room	Change After Repairs	Comments about Conditions during 2002 Carbon Dioxide Monitoring
	*ppm 1/17/1997	1/17/1997	*ppm 1/15,17-18/2002	1/15,17-18/2002	(+/-) *ppm	
A House Office Area	744	10				
A101 (Band Room)	744	40				
A201	650	12	872	18	+222	
A202	822	16	777	18	-45	
A203	550	14	909	16	+359	
A204	968	17	1005	16	+47	
A205	680	21				
A206	1100	14				
A307	570	0/12	835	26	+265	

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

TABLE 29

Carbon Dioxide Air Monitoring Results Comparing January 17, 1997 to January 15, 17-18, 2002
Peabody Veterans Memorial High School, Peabody, MA

Location	Carbon Dioxide	Occupants In Room	Carbon Dioxide	Occupants In Room	Change After Repairs	Comments about Conditions during 2002 Carbon Dioxide Monitoring
	*ppm 1/17/1997	1/17/1997	*ppm 1/15,17-18/2002	1/15,17-18/2002	(+/-) *ppm	
A308	1365	30	1107	22	-258	
A309	600	6				
A310	817	18				
A311	926	21	752	12	-174	
A312	782	16	894	24	+112	
A313	1050	24	1269	28	+219	
A314	958	26	1230	17	+272	
A315	1033	16	527	0	-506	Room empty of occupants
A316	1235	25	901	21	-334	Exhaust vent sealed with cardboard & duct tape, air purifier-on, window and door open-fan in window-on,

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

TABLE 30

Carbon Dioxide Air Monitoring Results Comparing January 17, 1997 to January 15, 17-18, 2002
Peabody Veterans Memorial High School, Peabody, MA

Location	Carbon Dioxide	Occupants In Room	Carbon Dioxide	Occupants In Room	Change After Repairs	Comments about Conditions during 2002 Carbon Dioxide Monitoring
	*ppm 1/17/1997	1/17/1997	*ppm 1/15,17-18/2002	1/15,17-18/2002	(+/-) *ppm	
						double occupied
A317	913	12	1260	18	+347	
A319	1061	23	1110	26	+49	
A320	926	26	1049	20	+123	
A321	937	22	510	0	-427	Room empty of occupants
A323	690	1/16	1206	27	+516	
A324	798	22	890	21	+92	
A326	1134	22	1265	25	+131	
A327	1280	18	661 1026	16 11	-619 -154	Window open Window open

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

TABLE 31

Carbon Dioxide Air Monitoring Results Comparing January 17, 1997 to January 15, 17-18, 2002
Peabody Veterans Memorial High School, Peabody, MA

Location	Carbon Dioxide	Occupants In Room	Carbon Dioxide	Occupants In Room	Change After Repairs	Comments about Conditions during 2002 Carbon Dioxide Monitoring
	*ppm 1/17/1997	1/17/1997	*ppm 1/15,17-18/2002	1/15,17-18/2002	(+/-) *ppm	
A328	822	16	1085	27	+863	
A329	750	11				
B House office area	544	5				
B107	827	13	997	12	+170	
B108 (Cosmetology)	757	7				
B110 (Woodshop)	559	8	519	0	-40	
B230	830	15	1276	19	+446	
B231	588	18	994	14	+406	
B232	520	13	838	22	+318	

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

TABLE 32

Carbon Dioxide Air Monitoring Results Comparing January 17, 1997 to January 15, 17-18, 2002
Peabody Veterans Memorial High School, Peabody, MA

Location	Carbon Dioxide	Occupants In Room	Carbon Dioxide	Occupants In Room	Change After Repairs	Comments about Conditions during 2002 Carbon Dioxide Monitoring
	*ppm 1/17/1997	1/17/1997	*ppm 1/15,17-18/2002	1/15,17-18/2002	(+/-) *ppm	
B233	554	18	713	18	+159	
B235 (Lab)	620	6	736	2	+116	
B236 (Art)	525	7				
B237 (Crafts)	742	11	605	11	-137	
B239 (Food Lab)	692	9	822	17	+130	
B240 (Student Lab Kitchen)	741	13	512	0	-229	Room empty of occupants
B242	722	6	700	11	-22	
B243	800	1	695 699	1 15	-105 -101	
B344	650	11	885	19	+225	

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

TABLE 33

Carbon Dioxide Air Monitoring Results Comparing January 17, 1997 to January 15, 17-18, 2002
Peabody Veterans Memorial High School, Peabody, MA

Location	Carbon Dioxide	Occupants In Room	Carbon Dioxide	Occupants In Room	Change After Repairs	Comments about Conditions during 2002 Carbon Dioxide Monitoring
	*ppm 1/17/1997	1/17/1997	*ppm 1/15,17-18/2002	1/15,17-18/2002	(+/-) *ppm	
B345	824	14	960	24	+136	
B346	480	0				
B347	904	9	1225	19	+321	
B348	855	16	1200	12	+345	
B349	985	26	560	1	-425	24 less occupants than 1997
B350	1210	29	780	17	-430	
B351	1147	19	785	28	-362	Window open
B352	947	13	999	19	+52	
B353	960	17	1247	20	+287	

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

TABLE 34

Carbon Dioxide Air Monitoring Results Comparing January 17, 1997 to January 15, 17-18, 2002
Peabody Veterans Memorial High School, Peabody, MA

Location	Carbon Dioxide	Occupants In Room	Carbon Dioxide	Occupants In Room	Change After Repairs	Comments about Conditions during 2002 Carbon Dioxide Monitoring
	*ppm 1/17/1997	1/17/1997	*ppm 1/15,17-18/2002	1/15,17-18/2002	(+/-) *ppm	
B355	1010	20	1500	21	+490	
B356	936	15	1154	25	+218	
B357	1120	22	780	22	-340	
B360	1020	23	610	0	-610	Room empty at time of testing
B361	928	18	1100	17	+172	
B362	1202	23	684	14	-518	
B363	677	20	694	16	+17	
Business Office-Dept. Head Office	689	1				
C House Office Area	620	2				

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Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
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> 800 ppm = indicative of ventilation problems

TABLE 35

Carbon Dioxide Air Monitoring Results Comparing January 17, 1997 to January 15, 17-18, 2002
Peabody Veterans Memorial High School, Peabody, MA

Location	Carbon Dioxide	Occupants In Room	Carbon Dioxide	Occupants In Room	Change After Repairs	Comments about Conditions during 2002 Carbon Dioxide Monitoring
	*ppm 1/17/1997	1/17/1997	*ppm 1/15,17-18/2002	1/15,17-18/2002	(+/-) *ppm	
C264	697	3				
C265	1130	11	984	15	-146	
C266	500	0	657	9	+157	
C267	969	23	468	0	-501	Room empty of occupants
C269 (Lab)	700	15				
C271	771	3	552	0	-219	Room empty of occupants
C272	748	7	1110	16	+362	
C274	775	15	808	14	+33	
C276	797	16	541	7	-256	

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Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
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> 800 ppm = indicative of ventilation problems

TABLE 36

Carbon Dioxide Air Monitoring Results Comparing January 17, 1997 to January 15, 17-18, 2002
Peabody Veterans Memorial High School, Peabody, MA

Location	Carbon Dioxide	Occupants In Room	Carbon Dioxide	Occupants In Room	Change After Repairs	Comments about Conditions during 2002 Carbon Dioxide Monitoring
	*ppm 1/17/1997	1/17/1997	*ppm 1/15,17-18/2002	1/15,17-18/2002	(+/-) *ppm	
C277 (Typing)	719	9	651	17	-68	
C279	593	2	441	0	-152	Room empty during assessment
C280 (Photolab)	788	12				
C380	840	10	1654	22	+814	
C381	706	8	1453	25	+753	
C382	520	5	721	0	+101	
C383	845	15	744	15	-101	
C384	770	11	846	19	+76	
C385	1155	18	1087	12	-68	

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Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
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> 800 ppm = indicative of ventilation problems

TABLE 37

Carbon Dioxide Air Monitoring Results Comparing January 17, 1997 to January 15, 17-18, 2002
Peabody Veterans Memorial High School, Peabody, MA

Location	Carbon Dioxide	Occupants In Room	Carbon Dioxide	Occupants In Room	Change After Repairs	Comments about Conditions during 2002 Carbon Dioxide Monitoring
	*ppm 1/17/1997	1/17/1997	*ppm 1/15,17-18/2002	1/15,17-18/2002	(+/-) *ppm	
C386	930	17	918	17	-12	
C387	842	15	1922	22	+1080	
C389	817	17	874	29	+57	
C390	737	16	543	0	-194	Room empty of occupants
C392	868	17	822	6	-46	
C393	1010	14	1074	1	+64	
C395	530	5	888	9	+358	
C396	730	10	1020	7	+490	
C397	1060	17	1235	24	+175	

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
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> 800 ppm = indicative of ventilation problems

TABLE 38

Carbon Dioxide Air Monitoring Results Comparing January 17, 1997 to January 15, 17-18, 2002
Peabody Veterans Memorial High School, Peabody, MA

Location	Carbon Dioxide	Occupants In Room	Carbon Dioxide	Occupants In Room	Change After Repairs	Comments about Conditions during 2002 Carbon Dioxide Monitoring
	*ppm 1/17/1997	1/17/1997	*ppm 1/15,17-18/2002	1/15,17-18/2002	(+/-) *ppm	
C398	1140	12	1124	22	-16	
C399	774	31	535	7	-239	24 fewer occupants than 1997
Cafeteria	1105	400	1478	~600	+373	
Counselor 1B	829	2				
Counselor 2B	997	1				
Counselor 1A	661	2	751	1	+90	
Counselor 2A	640	1	703	0	+63	
Day Care Center	786	11				
Director A	641	2	696	1	+55	

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

TABLE 39

Carbon Dioxide Air Monitoring Results Comparing January 17, 1997 to January 15, 17-18, 2002
Peabody Veterans Memorial High School, Peabody, MA

Location	**Carbon Dioxide**	**Occupants In Room**	**Carbon Dioxide**	**Occupants In Room**	**Change After Repairs**	**Comments about Conditions during 2002 Carbon Dioxide Monitoring**
	*ppm 1/17/1997	1/17/1997	*ppm 1/15,17-18/2002	1/15,17-18/2002	(+/-) *ppm	
Director B	760	2	988	1	+228	
English Office	670	1				
Faculty A	481	1	461	7	-20	
Faculty B	431	2				
Faculty C	485	1				
Library	620	10	423	15	-197	
Plant & Animal (B)	590	0				
Student Records Office	663	1				
TV Studio	720	3	448	0	-288	Room empty during assessment

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
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> 800 ppm = indicative of ventilation problems

TABLE 40

Carbon Dioxide Air Monitoring Results Comparing January 17, 1997 to January 15, 17-18, 2002
Peabody Veterans Memorial High School, Peabody, MA

Location	Carbon Dioxide	Occupants In Room	Carbon Dioxide	Occupants In Room	Change After Repairs	Comments about Conditions during 2002 Carbon Dioxide Monitoring
	*ppm 1/17/1997	1/17/1997	*ppm 1/15,17-18/2002	1/15,17-18/2002	(+/-) *ppm	
Outdoors	450		410 1/15/02 365 1/17/02 324 1/18/02			

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
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Appendix 1
Peabody Veterans Memorial High School
April 2002

Actions on Previous Recommendations

As discussed, BEHA had previously made recommendations to improve indoor air quality (MDPH, 1997). The Peabody School Department (PSD) and PVMHS staff had implemented a number of these recommendations at the time of the reassessment and these efforts should serve to help improve indoor air quality in the building. The following is a status report of action(s) on BEHA recommendations based on reports from school officials, documents, photographs and BEHA staff observations.

1. **Increase fresh air supply. If not feasible, replace univents with a new system. As an interim measure, reduce room occupancy.**

   Action Taken: As of the writing of the original report, plans to convert the heating system from electric to an alternative system have not moved forward. At the time of the reassessment, room occupancy was above the numbers recommended in the MDPH 1997 IAQ report.

2. **For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low.**

   Action Taken: Cleaning protocols were reportedly established by PVMHS at the time of the initial MDPH assessment.

3. **Establish exhaust ventilation for science labs, cosmetology and kitchen areas, and operate during school hours.**

Action Taken: Exhaust ventilation was operating in a number of areas. Cooking odors from the student restaurant continue to be distributed through the upper floors from the continued practice of keeping hallway and stairwell fire doors open. The spread of food odors from the student restaurant indicates less than adequate exhaust ventilation.

4. **Prevent blockage of univents with obstructions.**

   Action Taken: Univents remain obstructed in a number of classrooms (see Tables).

5. **Prevent univent deactivation by building occupants.**

   Action Taken: Univents were deactivated throughout the building (see Tables).

6. **Repair and operate general exhaust vents.**

   Action Taken: A number of exhaust vents were deactivated, obstructed, weak or inoperable throughout the building (see Tables).

7. **Remove wood panels above lockers in classrooms to enhance exhaust ventilation.**

   Action Taken: Wood panels remained in place in all classrooms evaluated.

8. **Have the building envelope (roof and exterior walls) evaluated by a qualified consultant for moisture incursion.**

   Action Taken: It was unclear whether this occurred, as no reports were available concerning this at the time of this reassessment.